TEXTILE RESEARCH

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CONTENTS

The Editor's Page 46
Fifth Annual Meeting of the Institute 47
Minutes of Corporation Meeting 51
Importance of the Interpretation of Scientific Textile Research. Prof. E. R. Schwarz 53
Essentials of Scientific Research Interpretation. Dr. R. E. Rose 58
Address of Dr. Karl T. Compton 61
Remarks of Mr. Franklin W. Hobbs 64
Annual Report of Board of Directors 65
Secretary's Annual Report 68
Research Committee's Annual Report 70
Use of the Polarizing Microscope in Cotton Classing. C. L. Pattee 72
Micro-Analysis of Textile Fibres. G. Gordon Osborne ... 75
Silk Degumming. R. H. Walters and O. A. Hougen 92
Dichroism of Dyed Fibres as a Means of Studying Micellar Arrangement. D. R. Morey 105
Abstracts 110

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The Editor's Page

REALIZATION that the wealth of new scientific textile knowledge, that is the result of chemical and physical research, is not being made available in intelligible language to those who would be willing to use it, was the reason why the principal subject discussed at the recent annual meeting of U. S. Institute for Textile Research was the interpretation of scientific textile research. The discussions of this subject by Prof. Schwarz and Dr. Rose, as published in this number, emphasize and clarify it and require no interpretation.

Logical interpretation of the addresses of Dr. Compton, chairman of the advisory committee of the Textile Foundation, and of Mr. Franklin W. Hobbs, chairman of the Foundation's board of directors, places responsibility for the interpretation of Foundation researches upon that organization and U. S. Institute, the interpretation to be made possible by some co-operative arrangement with publication of the results in *Textile Research*.

The need of scientific research interpretation will be apparent to textile executives and technicians who read the three scientific reports published in this number. Yet they are much less abstruse than many other published reports of Foundation studies.

It is the report of Osborne's study on the Structure of Ramie that Prof. Schwarz interprets in his address as proving that ramie "is inherently weak in torsion and bending" instead of being one of the strongest textile fibres, as has been generally accepted heretofore. The value to the industry of this knowledge will be appreciated by those who know of the millions of dollars that have been spent in unsuccessful attempts to process this fibre, and also by those who, in the future, may be asked to invest in ramie manufacture.

Another example of textile research interpretation, and also of its practical application, is the use of the polarizing microscope in the classing and buying of cotton, as referred to by Prof. Schwarz and as described in an article from *Textile World* that is reprinted in this number.

Fifth Annual Meeting of the Institute

THE reports of directors, committees and officers, presented at the fifth annual meeting of U. S. Institute for Textile Research, Inc., held at the Hotel Pennsylvania, New York, N. Y., Thursday, Nov. 1, reflected gratifying progress toward the Institute's objectives. An exception that was emphasized is an inadequate number of contributing memberships to provide for the financing of its research projects. Pending a sufficient increase in the number of these $100 memberships other methods of financing must be devised, and attention was directed to a study of the warp-sizing of cottons and rayons, funds for whose financing are being solicited from mills and firms which should be directly interested.

The outstanding feature of the meeting was the discussion of ways and means for the interpretation to the industry of scientific textile research. Its importance, and examples of the translation of abstruse reports into non-scientific language, were stressed in papers by Prof. Edward R. Schwarz and Dr. Robert E. Rose. They also emphasized the difficulties involved, agreeing that it was a job that could be done satisfactorily by no one or few men. Franklin W. Hobbs, chairman of the Textile Foundation, seemed to think that the interpreting should be done by the Institute through its magazine, TEXTILE RESEARCH. Dr. Karl T. Compton, president of Massachusetts Institute of Technology, chairman of the advisory committee of the Textile Foundation, and chairman of the National Science Advisory Board, expressed the opinion that, in the solution of this problem and in the attainment of all mutual objectives, it is very important for the Textile Foundation and the Institute to survey their situations and see to what extent a closer co-operation between them may be possible.

The annual meeting and luncheon of the Corporation was preceded and followed by meetings of the Board of Directors, attendance at which was much larger than usual. President Garvan presided at the Corporation meeting, 75 members and guests being present.

The Institute had as its guests Dr. Karl T. Compton; Franklin W. Hobbs, chairman, and Edward T. Pickard, secretary and assistant treasurer of the Textile Foundation; Dr. Charles H. Herty, former president of the American Chemical Society; Dr. H. A. Barton, director, American Institute of Physics, and Howard Poillon, president, Research Corporation.

Directors and Officers Elected

The report of the Nominating Committee (Alban Eavenson, Chm., E. N. Hood and P. A. Johnson) presenting the following list of Directors for a three-year term expiring in 1937, was adopted unanimously: Joseph Bancroft, Jos. Bancroft & Sons Co., Wilmington, Del.; J. E. Edgerton, Pres., Lebanon Woolen Mills, Lebanon, Tenn.; Philip A. Johnson, Pres. & Treas., Aspinook Co., Jewett City, Conn.; Dr. Robert E. Rose, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.; H. V. R. Scheel, New York, N. Y.; Dr. H. DeWitt Smith, Treas., A. M. Tenney Associates, New York, N. Y.; P. J. Wood, Apex-Oriental Corp., Haledon, N. J.

At the afternoon meeting of the Board of Directors the Nominating Committee's report, covering officers and members of the Executive Committee, was adopted unanimously, and is as follows: President, Hon. Francis P. Garvan; Vice-Presidents: Alban Eavenson, Louis A. Olney, H. M. Chase, Thomas T. Clark, A. L. Lustig; Treasurer, Ernest N. Hood; Secretary, Charles H. Clark; Executive Committee: Alban Eavenson, Ernest N. Hood, Joseph Bancroft, Philip A. Johnson, Robert E. Rose, H. DeWitt Smith. Messrs. Olney, Chase and Lustig are new vice-presidents, and Messrs. Rose and Smith are new members of the Executive Committee.

At a meeting of the Executive Committee, following the afternoon meeting of the Board of Directors, Alban Eavenson was elected chairman.

Dr. Killheffer and Mr. Gilmore Honored

It having been reported at the meeting of the Board of Directors that Dr. Elvin H. Killheffer and George L. Gilmore, both of whom had taken an active part in the organization of the Institute as officers and directors, and had been largely responsible for its progress since then, were in poor health and had been obliged thereby to relinquish business activities, the Board adopted a set of resolutions in honor of Dr. Killheffer and another in honor of Mr. Gilmore, expressing their deep appreciation of services rendered to the Institute, and the hope that they may soon be restored to complete health.

New Members Elected

The following applicants for annual membership were elected by the Board of Directors: G. E. Hopkins, Technical Director, Bigelow-Sanford Carpet Co., Thompsonville, Conn.; National Adhesives Corp., New York, N. Y., auth. rep., A. D. Fuller, Vice-Pres.; Richards Chemical Works, Jersey City, N. J., auth. rep., P. Kaplan, Vice-Pres.; The Viscose Co., Marcus Hook, Pa., auth. rep., Dr. Charles S. Venable.

The Corporation Meeting

The annual meeting of the Corporation started with luncheon at 12:30 P. M., and several of the formal reports were read and accepted between

courses, Vice.-Pres. Eavenson acting as chairman of this session. Minutes of the last meeting (Nov. 2, 1933) having been received by all members of that date were approved without reading. The reports of the Board of Directors, Treasurer, Auditor, Secretary and Research Committee, as accepted by the Corporation, are published in this number of the magazine.

Pres. Garvan's Remarks

In opening the speaking program that followed the luncheon and Corporation meeting, Pres. Garvan referred to two plans of educational work that are being developed by the Chemical Foundation, of which he is president. One involves the development of a course that will run through four years of high school and four years of college work, and is designed to educate the youth of the country in correct economic principles of government and banking, to the end that they may understand their proper functions, and their cost to the public when they depart from sound principles.

He also referred to the fact that the Chemical Foundation has started a campaign to solve the farm problem. "At one end of the avenue," he said, "they are destroying farm products, plowing under cotton, and at the other end of the avenue we are seeking to encourage the application of science to our present condition. There are a hundred new industries which could be started, which would take up surplus farm products. Henry Ford has started to use a half-bushel of soy beans in every one of his automobiles. Dr. Herty in his fine work offers them the building of a hundred mills and the production of over two hundred millions of product with its employment of foresters, paper mill employees, the builders of the factories, and so forth and so on.

"Present annual imports of over a billion pounds of tung oil should be displaced by oil which can be better produced in the South. The use of 10% alcohol and gasoline would create a market for a large percentage of surplus corn and other products; a large part of the sweet potato crop could be used for making starch, and so on.

"If the Government will only help us and encourage us in the development of these products, we will promise them that within a very few years the farmer can go ahead and produce all that his soil is capable of producing.

"I want to say one thing about Dr. Herty and his great work: that we now know that it is not alone paper which can be made from the southern slash-pine, but also alpha-cellulose, which is so important to your textile industry. In a very short time I think he will come before you and give you the results of his researches, to show you that, if the shift of the world's textile business is from cotton to wood, the same South and the same acres can keep pace with that progress and furnish you with the cheapest basic raw material in the world.

"If the spirit of research in which you have become so zealous were applied to the body politic, that research might mean a more strengthened and stable industry—your industry and all the other industries of the country." (Applause.)

Interpretation of Scientific Research

The first speaker introduced by Pres. Garvan was Edward R. Schwarz, associate professor of textile engineering, Massachusetts Institute of Tech-

nology, and also a member of the Research Committee and chairman of the Board of Edtiors of U. S. Institute, whose paper on The Importance of Scientific Textile Research is published in this number.

Prof. Schwarz was followed by Dr. Robert E. Rose, director, technical laboratory, organic chemicals dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., and president, American Association of Textile Chemists and Colorists, whose subject was The Essentials of Scientific Research Interpretation; this paper will also be found in this issue.

Pres. Garvan introduced the next speaker, Dr. Karl T. Compton, president, Massachusetts Institute of Technology, as "the man who I think holds the most important position in the United States today, because as chairman of the National Science Advisory Board it is his task to interpret the advances of science into the efficiency of modern government in this country." Dr. Compton's remarks, which were extemporaneous, will be found in this issue.

The other guests called upon Pres. Garvan, and who spoke briefly and extemporaneously, were Franklin W. Hobbs, chairman of the Textile Foundation, whose remarks will be found on another page of this issue, and Dr. Charles H. Herty, former president of the American Chemical Society.

Origin of Textile Foundation Fund

Dr. Herty spoke in part as follows:

"I am only going to say one word to you because my mind has been going back during all of this discussion today to one day in Paris in 1919. Through the instigation of this Irishman here (Mr. Garvan), they bundled me off on a boat and sent me over to Paris to see about some dyestuffs. When I think about the Textile Foundation and all it means, I go back to one morning when our commissioner, in charge of all the reparation clauses of the Versailles Treaty, brought into my room (I was working with him) a long cable from the State Department in Washington.

"In that cable, they insisted that in taking the dyestuffs which were coming into the United States, they be credited or paid for to Germany in gold marks. I don't know whether you realize it, but it was the fight that we made on that one cable that was responsible for the Textile Foundation.

"I said to the commissioner: It is out of the question. There isn't a single thing in the Treaty that specifies gold marks. It simply says 'marks', and if the Germans saw fit to debase their currency intentionally to wipe out their internal debts and so forth, that is their lookout. But we must insist at home that these be paid for in 'marks'.

"The result was, as you know, that those dyes came in here, due to the depreciation of the currency, for practically nothing, and be it said to the everlasting credit of the textile industry, they agreed that in the distribution of those dyes they should be paid for by the textile industry of this country at current market rates in the United States, so as not to kill the budding American dye industry. In turn, they were promised that any surplus funds accumulated would be devoted to research. That was carried through. Some $1,600,000 became available. But it all goes back to that struggle that we had over a week's time, cabling back and forth each day, and insisting that the reparation dyestuffs should be paid for in terms of marks, rather than gold marks.

"Let me say this, also; that when the question came up as to how that money should be used, both Mr. Garvan and Mr. Hobbs sought my

advice. I said, 'For goodness sake, don't let that fund go into buildings, into bricks and mortar, and be dissipated, but put it into brains, and in the most fundamental way possible for the textile industry.' And they have kept their word on that point.

"Finally, let me say that I never played but one bunco game in my life, and I played it on Karl Compton, who is right here. He came into my office one day, with his customary courtesy and tact, to consult me in regard to plans to help the Foundation. At that time, my head was so full of machinery for a paper laboratory down in Savannah that I knew I didn't have a thought in the world that was worth a cent. But I listened gravely, looked learned and wise, and encouraged him to talk. He talked and made his own ideas clear. I didn't contribute a single thing to it, but he made the Foundation program." (Applause.)

The Program Committee

The committee having charge of preparing the program for the meeting was the following: Dr. W. E. Emley, Chm., Dr. H. DeWitt Smith, Alban Eavenson, Prof. E. R. Schwarz, C. H. Clark.

Minutes of Corporation Meeting

THE fifth annual meeting of the Corporation, called for 10 A. M., was convened at 11 A. M., with Vice-Pres. Eavenson in the chair, but as less than the required quorum was present the meeting was adjourned until 12:30 P. M.

The adjourned meeting was called to order by the President, and, the Secretary having reported a quorum present in person, the meeting was declared ready for business.

The Business Session

The agenda of the annual meeting was acted upon during and immediately following the luncheon, Vice-Pres. Eavenson acting as chairman at the request of Pres. Garvan. The agenda as acted upon was as follows:

1.—Voted: That the minutes of the last meeting (Nov. 2, 1933), having been received by all members as of that date, be accepted without reading and filed.

2.—Voted: That the annual report of the Board of Directors, as read by the Secretary, be accepted and filed.

3.—Voted: That the report of the Treasurer, as read in outline form by the Secretary, be accepted and filed.

4.—Voted: That the acceptance of the Auditor's report by the Board of Directors be confirmed.

5.—Voted: That reading of the report of the Secretary be omitted, and that it be accepted and published in the next number of TEXTILE RESEARCH.

6.—Voted: That the report of the Research Committee, as read by Chairman Emley, be accepted and filed.

7.—Voted: That the Nominating Committee, as appointed by the Secretary on authorization of the President, be accepted by the Corporation as the committee on nomination of directors succeeding those whose terms have expired, and

8.—That the Secretary be instructed to cast one ballot for the following list, presented by Chairman Eavenson of the Nominating Committee: Directors for a three-year term, expiring in 1937: Jos. Bancroft, Jos. Bancroft & Sons Co., Wilmington, Del.; J. E. Edgerton, Pres., Lebanon (Tenn.) Woolen Mills; Philip A. Johnson, Pres. & Treas., Aspinook Co., Jewett City, Conn.; Dr. Robert E. Rose, E. I. du Pont de Nemours & Co., Wilmington, Del.; Dr. H. DeWitt Smith, Treas., A. M. Tenney Associates, New York, N. Y.; Charles B. Nichols, Treas., Otis Co., Three Rivers, Mass.; H. V. R. Scheel, New York, N. Y.; P. J. Wood, Apex-Oriental Corp., Haledon, N. J.

9.—Voted: That the business meeting be adjourned.

Treasurer's Annual Report

Your Treasurer's report for the fiscal year ended Sept. 30, 1934, shows income of $8,790.38, and expenses of $8,643.38, leaving a debit balance of $147.00. The latter compares with $63.23 at the close of the 1932–33 fiscal year.

His balance sheet as of Sept. 30, 1934, was as follows:

Assets:	Cash	$ 147.00	
	Funds in Permanent Account	2,000.00	
	Interest on Funds in Permanent Account	245.53	$2,392.53
Liabilities:	Permanent Funds not available for current use	$2,000.00	
	Cash and Interest Accrued available for use	392.53	$2,392.53

Auditor's Report

The report of Auditor William W. Buffum, as of Sept. 30, 1934, is as follows: "I have examined the books of account of the United States Institute for Textile Research, Inc., and find them correct. The expenditures are supported by proper vouchers and the balance on hand, $147.00, as shown by the books when reconciled with outstanding checks is certified by the statement from the Second National Bank of Boston.

"The Permanent Fund of $2,000 is deposited, $1,000 with the Salem Five Cents Savings Bank and $1,000 with the Salem Savings Bank, and, plus interest of $245.53, agrees with the pass books from these banks."

Importance of the Interpretation of Scientific Textile Research

By PROF. EDWARD R. SCHWARZ

THE United States Institute for Textile Research, Inc., in 1932 recognized the importance of presenting for the benefit of the industry a volume which would review the important features of textile research up to that time. It became apparent to the Board of Editors that such a review would be rendered of greater value to the mill man if it could be popularized to some extent. It was not easily possible to arrange this, however, since most of the 24 contributors had already submitted their material, and rewriting would have seriously delayed publication. Dr. Bush, Vice President and Dean of Engineering of the Massachusetts Institute of Technology, very kindly acceded to the Editor's request for co-operation by writing an introductory chapter in more or less popular vein. This has been widely quoted and is so much to the point that I offer no apology for taking my text from it. Dr. Bush significantly called his chapter "The Key to Accomplishment" and I wish to stress that last word "Accomplishment." That, after all, is what the textile manufacturer is most interested in. I recommend the entire chapter for your careful reading if you have not already done so, and, if you have, I suggest in all earnestness that you read it again in the light of what is to be said here today.

> Quoting Dr. Bush: "I believe that the executive today of an important industry involving a complex technique should himself understand research to a sufficient extent to speak the language and to mix freely and usefully with research workers. It is just as necessary, in my opinion, for the modern executive to understand the examination of fibres under polarized light as to know the mechanics of a spinning frame or to be able to read a balance sheet. Of course he cannot hope to know all the underlying optics, any more than he would attempt to operate personally any and all of the machines in his plants, or keep up with all of the intricacies of present day cost accounting systems; but he can understand those things which are important to his business and this is now one of them."

Before becoming willing to underwrite an undertaking the sponsor must either have faith more or less blindly in the project, or else he must have a confidence in it born of understanding of its nature and possibilities. In textile research the former condition of faith, on the part of the industry in general, is now lacking and has been consistently lacking, at least in this country, for many years.

In order to raise money for the financing of textile research of fundamental character and of importance to the entire industry, appeals have been made to individual firms, to groups of mills and to various organiza-

tions. When it is stated that the major research of value is now being done by organizations such as the Textile Foundation, the American Association of Textile Chemists and Colorists, government departments and bureaus and by educational institutions, with little or no assistance financially from the industry as a whole, the research worker is justified in crying out "Oh ye of little faith!"

It is at once apparent, therefore, that those interested in the establishment of a co-ordinated textile research program must fall back upon the creation of a better understanding in the minds of the holders of the purse strings of the industry as to the possibilities of accomplishing things through research.

We have about us an increasing multitude of witnesses bearing testimony to the nature of fundamental problems concerning textile fibres, yarns and fabrics, but unfortunately they do not speak the same language as the judge and jury.

In a court of law such witnesses would, as a matter of course, be furnished the expert services of an interpreter so that their testimony might be given in understandable terms.

An interpreter, or rather a group of interpreters, is needed now to translate the findings of the present and past textile research workers into terms which can be appreciated by the textile executive. But do not expect too much of the interpreter. His task is not to present you with the application of a particular research to the solution of your immediate problem. He may sometimes, by accident, be able to do this. His purpose is rather to lay before you, in language you can understand, the significance of related studies in physics, chemistry, biology or mathematics.

Perhaps an illustration is in order. Let me quote from a recent Textile Foundation report published in your own journal, TEXTILE RESEARCH.

> "If dye molecules attach themselves to the underlying fibre structure in a definite single-valued manner, we have at once a means of studying the structure. . . . There are a number of indications that, for certain dyes, the attachment of dye molecule to micelle is directionally single-valued. These indications, dealing with anisotropic forces of the Van der Waals' type result in dichroic phenomena."

This statement conveys the exact story to the person familiar with the technical aspects of polarization of light, fluorescence, stoichiometric chemistry, etc.; but I venture to say that it is nothing but a meaningless jumble of sounds to the average textile executive.

Let me hasten to offer the writer's own translation and popularization of his statement as just read. He says:

> "The manner of attachment of a dye molecule to the ultimate fibre structure may be illustrated by means of an ordinary electric light bulb and its socket. The bulb may be attached to the socket only in a definite manner which preserves for any position of the socket the same relative arrangement of the parts. We may deduce the arrangement in space of a number of sockets in a room, even though they were not directly visible, by looking at the luminous bulbs. By properly dyeing the fibres we

> figuratively attach to the structural units (the micelles) little light bulbs (fluorescent dye molecules) which indicate the micellar positions. A union of micelle and dye molecule which could occur with different relative positions of the two would not permit the application of this method.''

Unfortunately, but few research workers have the happy faculty of being able to interpret their work in popular style. In this case, however, one must admit a better understanding of what is meant by the study of textile fibre structure by means of the orientation of polarized fluorescence.

It is further important that this particular investigation should not be allowed to stand alone. With it should be combined the interpretations of other allied researches.

A field general attacking an enemy position in wartime endeavors, by all possible means, to surround the force which he wishes to defeat, then proceeds to attack with infantry, tanks, airplanes, gas and heavy artillery. What any one force may not be able to accomplish alone, all working in unison may do easily. Thus the competent research director brings to bear on the attack upon a problem, such as fibre structure, his microscopes to spy out the land; his heavy artillery of chemicals to burst and disintegrate the stronghold; his flares of fluorescent dyes to light the battlefield and to locate the enemy; his machine-gun hail of electrons from X-ray tubes; and finally his army of occupation, the mathematicians, whose task it is to consolidate the position. He captures the enemy and discovers his secrets. As a result he advances.

In the heat of the battle orders are given, maps are drawn, aerial photographs are taken, reports are made. After the battle these records remain. They are technical data. For the officer who expects to fight again on this or similar ground they form a straightforward account of the details of the action. To the layman they mean little or nothing. It is for the historian, in the light of his knowledge and background, and in view of his ability to speak and write the same language that the average citizen understands, to make clear to him what has happened and to show not only how it could happen again, how it could be prevented, but what influence it had upon national and international relationships and policies.

But I fear that the average historian would make a poor munitions manufacturer and probably a worse field marshal. His is simply the task of reporting what has happened in non-technical language. His is the greater task of interpreting the possible significance of the event. His reader must make his own application; must learn from it his own lesson.

To return to fibre structure. One investigator studies all the facts about fibres which his microscope and its accessories can show him. He discovers that all textile fibres have the power of polarizing light. He sees that the light which normally vibrated in many random directions, but always perpendicular to the path along which it travelled, after passage through a rayon filament (or any other fibre—natural or artificial) vibrates only in two planes mutually perpendicular to each other and to the path of the light. To him it is at once logical that this particular sort of light should be a splendid means by which to study fibre structure. He sends such light through the fibre and observes what happens, and a wholly new field for research opens up.

He soon finds that fibres have a certain "lining-up" of extraordinarily minute structure parallel to, or at certain angles with, the fibre axis. He notes that when the "lining-up" is most nearly parallel, the fibre is strong, elastic and brittle. He sees that when the "lining-up" is imperfect the fibre becomes weak, plastic and soft. He begins to grade the fibres and puts asbestos and ramie among those of the former type, and rayon and wool among those of the latter. He sees that ramie, for example, is inherently weak in torsion and bending and that no method of preparation of the fibre, whatever its cheapness or its cost, can change this without altering the fundamental properties of the material and without decreasing its strength and elasticity. To make it resistant to failure by flexing the strength must be reduced, and he realizes the limitations thus imposed.

On the other hand he sees that if the "lining-up" of rayon (he calls it orientation) could be made more nearly perfect, the fibre would be stronger and more elastic. Day by day he throws new light on the nature of the "lining-up." He fastens fluorescing molecules of dye onto the molecules of the fibre. He finds out (even though he cannot see them) how the molecules must be placed. He calls it in one case a study of micellar orientation by means of variation of polarized fluorescence, and in another the determination of the relative degrees of dichroism in polarized light. He is like the Greek. He has words for them. But to you, the interpreter simply says: if you want to improve your rayon, then increase the degree of "lining-up" of fundamental structure parallel to the fibre axis. The technically trained man in the rayon plant says: "Aha! I can do that by properly stretching the rayon while it is being formed at the spinnaret." Thus is stretch spinning of rayon born, and in that direction lies much of the future of rayon. It is the result of fundamental research properly interpreted, and followed by applied research to make possible an industrial application of value.

The silkworm orients its filaments somehow when it builds its temporary lodging. The physiologist, the biologist, the physicist and the chemist are uniting to try to find out how. Can we hope to make as good a fibre as the humble worm? Not until the scientist gets the opportunity and the funds to find out what the worm does chemically and physically. Not until (and this is important), not until his findings are made understandable to the textile man who must manufacture the filaments.

The scientist is trying to study things he cannot hope to see. No layman's understanding of the task can be possible until he appreciates something of the relative magnitudes of the quantities involved. If I were to draw a chalk line ⅜ inch wide across the wall of this room, I would have made a diagrammatic elevation of a cotton fibre to scale. Now you are well aware of the fact that in reality a cotton fibre is only an inch or two at most in length. But it is 3000 times longer than it is thick. Even if the fibre itself were actually as big as that line, the structure that is being studied by means of polarized light would still be too small to be seen through even the most powerful microscope. The investigator cannot enlarge the actual fibre to a point where he can see its ultimate structure directly. Neither can he "ensmall" himself sufficiently to actually wander about inside the fibre, surrounded by the maze of its structural framework, much as he would like to. What to do? Enter the X-ray beam, built up itself of units far smaller than the ultimate fibre structure.

The scientist using this means of study is something like a blind man standing in a field, who is confronted with a building of unknown shape and size. He has behind him a closely spaced row of metal tubes suspended vertically. Each differs in length from its neighbor. Each gives out a different musical note when struck. The blind man paces off the distance from the row of tubes to the building. He induces someone with faith in him to provide him with a plentiful supply of small rubber balls and an oversize air rifle. He stands facing the building and shoots repeatedly at it. Each ball bounces from the structure, now from the roof, now from a porch, now from a gable, now from an ell and upon its return journey it ends by striking a tube. By the note given forth, the blind man can tell the location of the tube in the row. He knows where the ball started and where it landed. He can then find out something of the placement of portions of the building. The longer he investigates the more he comes to know.

The scientist, initially at a similar disadvantage, substitutes an X-ray tube for the gun; emitted electrons for the balls; fibre for the building; and a photographic plate for the chiming tubes. He forces the X-ray beams to bounce off of the molecular framework of the fibre, strike the photographic plate and register thus the exact point of impact. Study of the plate then tells him how the framework of the fibre must have been built to make the X-rays behave as they did. He calls the photograph an X-ray diffraction pattern. By any other name it would mean as much to the unitiated. But we are no longer novices. We have been admitted to the inner circle. We understand something of the essentials of what the scientist is doing.

It is not a crude method as the very crude analogy of the blind man and the house might lead you to infer. The orientation of certain textile fibres, studied independently at the Massachusetts Institute of Technology with polarized light through the microscope, at Cornell by means of fluorescent dyes, and at the University of Illinois by X-rays, comes out the same figure within a degree or two.

What do you care about it? If you will refer to the October (1934) issue of the *Textile World* (p. 80) you will find how one mill uses a by-product of the polarized light studies on cotton in order to buy their cotton at a saving. The appearance of cotton in polarized light in a properly arranged microscope can be, and has been, definitely tied in with the formation of neps in the yarn, and with the spinning quality of the yarn as shown by actual mill practice.

Here is an excellent example of fundamental textile research, translated into terms which could be understood by the technical man in the mill, and which he proceeded to put into practical use. And the end is not in sight. We have only just begun. Psychologically it is a sound concept that we are afraid of what we do not understand. As long as scientific research in the field of textiles leaves the textile executive in ignorance as to what it is all about, so long will the research director and worker look in vain for adequate support.

Fundamental information must be sought and found in the future as it has been in the past, but our greatest need at the moment is proper interpretation of this growing store of basic facts so that valuable applications may follow, and, above all, so that the textile executive will actively support a co-ordinated research program because of his better and growing understanding of its findings.

Essentials of Scientific Research Interpretation

By DR. ROBERT E. ROSE

PROF. SCHWARZ has emphasized a point which cannot be too strongly stressed. As a matter of fact, I can tell you that when, more than four years ago, Dr. Emley asked my opinion of the need of an institute to further research in the textile field, I told him that I was not in favor of trying to develop new data when it was so obvious that the available material was not being utilized. As a research man, I wanted more research done, of course, but I felt that we might over-emphasize the new and slight the old. That the textile industry was not utilizing available information was quite apparent.

I had just had samples of very badly tendered cloth from one of our large mills. These were dyed with sulfur black, notoriously a dye that breaks down sooner or later to produce acid materials that destroy the cotton fibre; however, the choice of the color was appropriate for this cheap type of material. The complaint was that this cloth actually failed much quicker than it should. By the time the trousers made of it were ready for the wearer, they were no guarantee of respectability. We examined the whole case and found that the finish used, one bought under a trade name without analysis, was loaded with magnesium chloride, acid enough to destroy any cotton. That is perhaps an unfair, an extreme example of a mill beyond the pale of help by research, but I have seen enough to know that in many directions the comparatively well known facts of physics and chemistry are ignored.

What can be done to make available to those willing to use it, the wealth of material being turned out by chemical research? Let me use the past instead of the present from which to draw conclusions. I shall go back to the year 1811 when a professor in the University of Turin hazarded a guess to try to find an explanation for the comparatively simple volume relations that obtained when gas interacts with gas. In that year, Avogadro guessed that equal volumes of all gases under like conditions of temperature and pressure contain equal numbers of molecules. Between 1877 and 1887, this hypothesis was expanded to cover the behavior of substances in solution, and it was stated that solutions of equal molecular concentration in any one solvent possessed identical boiling and freezing points and exhibited identical osmotic pressure. It was, however, obvious that this was not nearly so true of solutions as of gases; particularly dilute solutions of acids, bases and salts gave very divergent results, and always in the direction of producing a greater effect than was to be expected. In 1887 a Swede, Svante Arrhenius, propounded the theory of electrolytic dissociation to explain these anomalies. This explanation was that in certain solvents, particularly water, molecules of acids, bases and salt underwent a chemical change, a dissociation into ions, each ion acting as an individual molecule bearing an electric charge.

All acids then were similar because they were solutions containing the same active ingredient, hydrogen-ion, and bases because of the presence in all of their solutions of hydroxyl ion. A strong acid was one highly dissociated by virtue of its inherent characteristics, and a weak one a feebly ionized substance.

All this was extremely interesting to the scientific world; it was the subject of much debate, and the methods for measuring the degree of ionization became more and more perfected as the disputants tried to prove or disprove the explanation by reaching a greater certainty regarding the facts—the only method admissible in scientific investigation.

The industrial world was blissfully indifferent to all this academic excitement. An acid remained something that turned blue litmus red, and a base one that turned it back to blue. Salts were neutral.

By the year 1910, it was accepted generally that the theory of Arrhenius was correct and that acid and base intensity was measurable in terms of hydrogen and hydroxyl ion concentration.

About that time, Sörensen, the great biological chemist, wished to record the very minute departures from neutrality that play so all-important a rôle in the living body. To plot curves going from a concentration of 1×10^{-3} gr. of ionized hydrogen to 3×10^{-3} per liter on co-ordinate paper was easy enough, but if the acid intensity jumped to 1×10^{-4} or 3×10^{-4} gr. ionized hydrogen per liter the curve ran off the paper hopelessly. It was then suggested that if the plot was constructed in terms of the logarithm of the reciprocal of the hydrogen ion concentration, manageable curves resulted; the quantities on this scale being denoted by the symbol "P_H." Still industry was indifferent although the magic pH (to write in its modern guise) had come into being.

In January, March and May, 1917, there appeared in the *Journal of Bacteriology* papers by W. Mansfield Clark and Herbert A. Lubs, discussing the determination of different pH ranges by dyes. While a great deal had been done and has since been done by others, it is probably no exaggeration to say that these papers were the interpretation that made pH measurements significant to the industrial chemist and finally to the operator of industrial processes.

The measurement of pH became easier and easier until it grew into a standard industrial habit of the very most vital importance. In dyeing, in scouring, in bleaching, in control of softened water, in silk degumming, the magic pH was accepted, even without any greater understanding of its deeper meaning than that it measured the relative strength of acid and alkali.

From 1887 to 1920 is 33 years. The first thirteen years, we can call still highly contentious. There remain twenty years required to utilize a known set of facts of great value to the textile industry.

During that time, all that had taken place was a translation of the following statement:

The molecular acids, bases and salts are dissociated in aqueous solution to produce an equilibrium between charged ions and undissociated molecules. The hydrogen ion concentration produced under any set of conditions is a constant for any one kind of molecule. Acidity is a property of solutions of hydrogen ion in concentrations above 1×10^{-7} gr. per liter; alkalinity, a property of solutions containing a hydroxyl ion concentration

greater than that of water. The measurement of the degree of ionization calls for special apparatus and a training in physics and chemistry.

This statement may be translated as follows: Acids differ tremendously in intensity; even the smallest amount of a strong acid is more intensely acid than a high concentration of a weaker one. The same is true of bases. Industrial chemical processes are just as sensitive to intensity as quantity.

Intensity can be measured easily with dyes by any intelligent human being. Control pH!

What caused the delay? It came of the lack of interest of the pure scientist in translating his ideas into anything at all like common language, and of the equal lack of interest in matters scientific on the part of the technical man.

Since then, the relation of science and industrial practice has grown much closer, but science has moved into more specialized fields where facts can be described precisely only in a language different from any mother tongue. This precision is absolutely essential, but it is not essential that the use of the facts should be inextricable from this language. The interpreter's task is harder, that is all.

What is needed, then, is the scientist who is not concerned in any way with the application of his research to other ends than that of satisfying the impractical curiosity of other similar men. He is already at work. Next, the scientifically trained man, sometimes the scientist, who has the gift of translating the language of science into the mother tongue. He is very hard to find and he must be encouraged by industry.

Finally, the scientifically trained executive, who can see the discoveries of research in relation to his own particular practical production problems. He is by force of circumstances unattainable, because the textile executive has no time to become a scientist. He should, therefore, delegate his authority to a scientifically trained assistant, who is able either to read the language of the scientist and translate as he reads or who can at least seize upon the translations of others and turn them to profit.

Above all things, let there be some one in every textile enterprise who is capable of that peculiar, logical, quantitative contemplation of the material about him, which is the scientific point of view and let him be no mere user of scientific methods of analysis, no mere tester, but a trusted thinker, who is to become more and more a trusted executive. Has not Francis, Lord Bacon, said: "For expert men can execute and perhaps judge of particulars one by one; but the general counsels come best from those that are learned,—studies themselves do give forth directions too much at large, except they be bounded in by experience."

Address of Dr. Karl T. Compton

AFTER the introductory remarks of your President, I feel a great sense of humility in trying to say anything at all—an even greater sense of humility than I had when I was first asked to appear on this program, because I then recalled that I had appeared before you two years ago and could scarcely conceive of why I should be asked to speak again. There was also the reservation that I was not a textile man, primarily. I had the feeling that somebody could bring you a message at this time that would be much more to the point than anything I could possibly say. It is true that I have measured pH, and have looked through and operated a polarizing microscope, but I submit to you that that doesn't make of me a textile man.

However, there is always a certain opportunity for help in a situation of this sort. I don't know whether any of you have heard the story about a young student down at Princeton who came from a very God-fearing, conscientious New England family. When he took his first examination and reached the end of his examination book, he came across that thing which is peculiar to Princeton, I believe, the honor pledge which goes something like this: "I pledge my honor as a gentleman that I have neither given nor received help during this examination."

His conscience began to trouble him. So he went up to his instructor and said, "Sir, I am not sure that I ought to sign this pledge."

The instructor said, "What is the trouble?"

He said, "Last night, as I was saying my prayers, I asked the Lord's help in this examination."

The instructor said, "Let me see your examination book."

He took it, looked it over, handed it back, and said, "Young man, I think you can sign it all right." (Laughter.)

Well, I want to use that story to say that for whatever inspiration I may have had from that source, or from any other, for these remarks, I did not do what was my first impulse, namely, to go straight to some of my good friends who know something about textiles and ask them what I ought to say under the circumstances. So I am entirely and personally responsible for what I do have to say.

My contact with textile problems, outside of my good friends on our own staff, has come largely in connection with the two great sister organizations working essentially toward the same objective—that is, the Textile Foundation, and this United States Institute for Textile Research. During the past four years, as I have had an opportunity to see some of the things that have been accomplished by these two organizations, it seems to me that it is very heartening for the future, despite the difficulties of the past and present, to realize some of the things that have been done.

Take, for example, the work of the Textile Foundation, as I have had a small opportunity to see it.

Our institution, along with several other educational institutions, was the beneficiary of a grant of money. We have used that to carry on a

program of textile research, supplemented by funds from our own budget, which has gone along principally four lines: first, the development of mechanical devices for the testing of textile fabrics; second, the research in textile microscopy which Professor Schwarz has alluded to; third, the invention of an instrument and its application to the analysis of color and the matching of color in dyed fabrics; and fourth, a study of textile bacteriology—that is, the effect on textiles of organisms which produce mildew and other deleterious actions.

We are in the process now, Mr. Hobbs, of preparing a report to the Textile Foundation on the accomplishments that have been made possible by this assistance. I do not know what the programs have been in the other institutions, but I have enough faith in those institutions to believe that it is a fair statement to say that this support by the Textile Foundation has been of real value, a value that probably will not be realized completely for some time to come.

A second activity of the Foundation was the establishment of the Textile Research Fellowships, which were inaugurated primarily for three purposes, and as I see the situation, these three purposes are given in the order of their relative importance: first, to stimulate in the leading university laboratories all over the country an interest in textile problems and in textile research, each Textile Research Fellow being looked upon as a nucleus for the development of such interest in those institutions; second, the drawing into the field of interest in textiles of a well selected group of scientifically trained young men, some of whom might ultimately actually be drawn into the industry itself; and, third, the actual handling and perhaps solution of some of the problems of basic scientific or technical importance; not shop problems or mill problems, but problems that might form the basis of large advances for the future.

This program, I believe, has been very useful. In my humble opinion, it is not being carried on as actively as its merits deserve, but it is still in operation and tangible results of value have already come from it.

The fourth activity of the Foundation that I would mention has been the survey of textile education, and as a result of that survey, the formulation of certain principles of textile education, certain policies that have been worked out after consultation with men who are expert not only in the educational field, but also in the manufacturing field. This survey, while completed and published, is still an active thing, because there will continue for some time to come a series of conferences between those who are most intimately interested in the problems of textile education, looking toward a reorganization or a development of textile education along these lines. Those and other things of that type have been great accomplishments by this organization.

Turning now to the other organization, your own organization, there has been a definite program carried on. It is not necessary for me to dwell on that, because you know it far better than I do, but things which stand out in my own mind are, for example, the publication and the popularization program that has been alluded to by the two preceding speakers; the publication of TEXTILE RESEARCH, for example, is a unique and very important function.

Naturally, your organization is made up of the men who are most interested in and most strategically located with respect to the introduction of ideas of research, results of research, and the method of research into

the actual operating industries of the country, so that you form a natural clearinghouse for the kind of activity in which we believe lies the future of the textile industry, for better textiles for the benefit of the public, and for a better situation within the industry itself.

The point of my remarks, based upon this background, is this: It seems to me that there is needed in the textile industry in all of its ramifications, to a remarkable extent, a degree of co-operation. Because of the historical background of the textile industry and its inherent nature, I think co-operation is a peculiarly difficult thing to bring about, but, by the same token, it is peculiarly important. These two organizations are the groups which are on the horizon and which have a peculiar opportunity to bring this co-operation about.

In order to do so, it seems to me the first step should be the closest possible co-operation between these two organizations themselves. I know that such co-operation has taken place in the past, and that it has been fruitful of good results. But I am very much convinced, based, I grant, on superficial knowledge, that there are far greater opportunities for co-operation between these two organizations in the future, more perhaps than even the members of the organizations realize at this time.

I might illustrate my remarks by the story which some of you may have heard of the poetry contest in an elementary school. There were three entries in this contest, Dan, Sadie and Sam. Dan got up and recited the following poem:

> "My name is Dan.
> When I grow up to be a man,
> I want to go to Japan,
> If I can.
> And I think I can."

Sadie's poem was this:

> "My name is Sadie.
> When I grow up to be a lady,
> I want to have a baby,
> If I can.
> And I think I can."

Sam came along with this one, which took the prize:

> "My name is Sam.
> When I grow up to be a man,
> I don't want to go to Japan.
> I want to help Sadie with her plan,
> If I can.
> And I think I can." (Laughter.)

I submit that the problem is here and that these two organizations are the Sam and the Sadie. I don't know which is which. That perhaps is a question for debate. (Laughter.)

But the possibilities of co-operation of this type in a very analogous situation, I think, are very well illustrated in two older types of organizations. I refer, on the one hand, to the great altruistic foundations of which perhaps the Rockefeller Foundation and the Carnegie Foundation are

the outstanding examples. Those were foundations which had at their disposal trust funds for altruistic purposes, with a program of wide vision.

On the other hand, there developed by necessity, at about the time of the War, an organization of the scientists of the country, in what is known as the National Research Council, which is the representative, organized group of the active scientists in the country. Of those two types of organizations, the Foundations had certainly much the broader problem. Their problem not only included science, but it included the humanities, the arts, social sciences, government, anything for which the funds could be used for the benefit of mankind. But in the particular field of science, their interests did very definitely overlap, and the co-operation between those two organizations in this overlapping field has been, to my mind, by far the most important single element in the development of science in this country during the past ten or twelve years.

So my suggestion is simply this: It seems to me that it is very important for these two organizations to survey their situations, and determine to what extent a closer co-operation between them may be possible along the line on which their objectives are common.

Reverting again to Sadie and Sam, I should say that it seems to me that this is the most important specific problem before the two organizations, if it can be handled, and I think it can. (Laughter and applause.)

Remarks of Mr. Franklin W. Hobbs

WITH reference to this research work, I think that both Prof. Schwarz and Dr. Rose have given us a very admirable suggestion. It is a very difficult thing to try to interpret what is going on. That was what led the Textile Foundation to financially support your magazine, TEXTILE RESEARCH, in order to have that work which we have been carrying on brought clearly before the industry so that they might know what was being done.

I appreciate very much the remarks that Dr. Compton made about the work the Foundation has been doing. I can tell you very sincerely and very heartily that I think the Textile Foundation owes a tremendous debt to Dr. Compton. We have found him at all times ready and willing to help us. He has been of tremendous value in many branches of the work we try to carry on. He has been free with his advice and help and assistance, and of great value to us—of tremendous value.

I can make the same remark about Prof. Schwarz, Dr. Rose and my dear old friend, Dr. Herty, in the selection of our research fellows. In that work we received tremendous help from all of these gentlemen.

Dr. Compton has been outstanding as the chairman of various committees. He was chairman of the committee that we asked to select a man to make the investigation of textile schools, to which he has referred. Last year, we made up our minds that there was a great field before us to try to get the textile schools into a better condition as to their requirements and their courses of study, to bring them to a more uniform basis.

Dr. Comptom again served as chairman of a committee to select a man to carry on that work for us, and Mr. Feiker, the man selected, has done an exceptional piece of work. We had a wonderful conference at Atlantic

City, Oct. 13 and 14, at which the representative men running the 11 textile schools of the country were present. Mr. Pickard was there, Mr. Feiker and myself. These men had scarcely known each other at the first of the year. Now, they have had several sessions of that sort, and are on most friendly and understanding terms.

As a result of the work already done and of further conferences that we propose to hold from time to time, I believe we are going to really do a very great service to the textile industry of the country by bringing about a closer harmony and higher and more uniform courses of study throughout all the textile schools of the country. That has been the latest thing that the Foundation has been doing; not possibly strictly scientific research, but a very practical service to the textile schools and to the textile industry. If anyone desiring a copy of Mr. Feiker's report will write to Sec. Pickard at the Washington office of the Textile Foundation, he will be glad to forward it.

Dr. Compton has suggested a possibly closer co-operation between the Textile Foundation and this organization. I can, I think, speak for the other members of the Board in assuring him that the Foundation has tried in every way to co-operate with this organization. We have helped to finance your magazine. We have taken up a great many of the subjects that you have suggested, and I know that there is every desire to work in the closest possible harmony.

It is a great problem, I think, to know how to get the results of scientific research through to the average man who is running a textile mill, so that he can understand what it is all about. With the help of you men here, I think this can be brought about in a better way than it ever has been in the past. If you can translate these findings of scientific research into plain language that the average man can understand I believe that you will be of great help to the textile industry. Thank you. (Applause.)

Annual Report of Board of Directors

YOUR Board of Directors and Executive Committee each held three meetings during the fiscal year 1933–34; the Research Committee or its Council held four meetings, and in addition two research conferences were held.

Your books of account have been audited by Mr. William W. Buffum, and his certificate of their correctness has been accepted and filed. Your Treasurer's report for the fiscal year shows a small debit balance, and the budget accepted for the current year provides for gross expenses no larger than last year, although it hopefully estimates an increase in income from memberships that is needed to defray at least part of the cost of researches planned by the Institute.

We believe that we are justified in pointing with some degree of pride to the following results of the year's work:

(1) To the fact that your officers, directors and committees have given more freely of their time and services than during any year excepting possibly our first.

(2) That this, our fourth year, is the first in which we have been able to pay all expenses out of regular sources of income, principally membership dues and magazine subscriptions, closing the fiscal year with a small debit balance.

(3) That there was an increase in paid memberships of 96, including renewals of 52 formerly on the complimentary list.

(4) That we were able to publish 12 issues of the magazine, instead of 10 last year, and 604 pages of text (including a 16-page index) as compared with the 528 text pages of Vol. III.

(5) That the conferences on wear-testing in March and warp sizing in May, both of which were designed to show the status of scientific research on these subjects, whether or not there was sufficient demand from the industry to justify further study, and to define the character of the studies, were highly successful in attendance (75 at the first and 100 at the second), in proving that the demand warranted further research, and in clearly outlining the character of the needed studies of the subjects.

(6) The fact that the Textile Foundation has seen fit to extend for another year the agreement by which the released reports of its fellows are published in our magazine, TEXTILE RESEARCH.

Research

You have before you the annual report of your Research Committee and your Directors believe that you should be as appreciative, as are they, of the large amount of time and effort that this committee, and particularly the members of the Research Council (Messrs. Emley, Smith, Eavenson, Blanchard, Schwarz and Clark) have devoted to this work during the year under reveiw. There are certain textile subjects awaiting scientific research whose need of such study and whose importance to some branch of the industry is self-evident. There are others whose importance is not so evident and that require clearer definition before their investigation may seem justified. We believe that the conference method initiated by your Research Committee for the discussion of such subjects is a valuable contribution to the research program. We regret, however, that, when a conference has endorsed a subject and defined the character of research, and its financing by some foundation or institution is not forthcoming, we are obliged, because of our continued lack of funds, to seek some other method of financing. Dependence upon institutions like the Bureau of Standards and Massachusetts Institute of Technology, who have kindly undertaken the study of the wear-testing problem, places us and the industry we represent in the position of beggars for needed service. When a group of 75 or 100 textile men endorse a certain research study they or their firms should be willing to co-operate in its financing. We are endeavoring to finance the warp sizing research in that manner. We are also working upon ways and means that we hope will provide a reasonable sum annually for our own research. Without reflecting in any manner upon the wonderful research program that the Textile Foundation is giving the industry, we believe that the individual members of the industry will value research that they help to pay for far more than that which they get for nothing. We are confident that any progress we make in securing more manufacturers and other textile men as members of U. S. Institute, and also as co-operators in the financing of our group researches, must tend proportionately to broaden the demand for and the utilization of scientific research.

Memberships

Memberships as of Sept. 30, 1933 and 1934, minus the 232 complimentary annual memberships that expired on the former date, were as follows:

	Sept. 30, 1933	Sept. 30, 1934
Life	2	2
Contributing	29	28
Annual	112	209
	143	239

During the fiscal year we lost eight old contributing memberships, of which four were transferred to the annual class; seven new contributing memberships were added, leaving 28 as of Sept. 30 last.

Of the 112 annual members as of Sept. 30, 1933, only 11 were lost. The additions since then include four transferred from the contributing class, and 104 new paid members, or a total of 209 at the close of our fiscal year. Of the new paid annual members 46 represented "complimentary" member renewals. The "complimentary" membership renewals were only 22½% numerically, but on the income basis, and due to six being renewed as contributing members, the percentage of renewals was 46%.

It will be seen that the largest single source of new members was the complimentary annual memberships that were financed by the Chemical Foundation, the income from which made possible the starting of our monthly magazine, and that also helped the financing of our book "Textile Research: A Survey of Progress." Your Secretary also credits the two research conferences with being valuable aids in membership work, and traces 16 new annual memberships directly to the warp sizing conference.

The Magazine, *Textile Research*

TEXTILE RESEARCH mailing list as of Sept. 30 was 412 copies, of which 309 are for members, including extra copies to contributing members; 52 go to non-member subscribers and 51 to the exchange and free list. Of each issue 500 copies were printed, but in anticipation of an increased demand the November issue was stepped up to 600.

In the 12 issues of Vol. IV we published, including a 16-page index, 604 text pages, as compared with 528 text pages in the ten issues of Vol. III.

Magazine receipts as of Sept. 30 were $3,648.99; expenses for printing, postage, etc., $3,633.26, leaving a credit balance of $15.73. Last year no issues were published in July and August, but the excess of expenses over receipts for the issues published in that fiscal year was $345.86.

We have entered into a revised agreement with the Textile Foundation, covering the space to be used by that organization in the magazine for the period ending November 1, 1935, which is substantially the same as the previous agreement as to charges, but that now covers a period of 14 months and ends with the next magazine volume, thus making it possible for us to budget probable magazine expenses for the volume and year, starting with the November number, upon a more definite basis. The old agreement ran from September to September thus leaving two numbers of the volume-year uncovered.

We know that you will agree that our Board of Editors and our Publications Committee are to be commended for their success in providing the textile industry of this country with a scientific publication of exceptional value to those who are capable of interpreting the reports and abstracts published. Their objectives for this magazine are far from being realized, and one of the most important is to be discussed at this meeting: the interpretation of scientific research.

The Book, "Textile Research: A Survey of Progress"

Only 47 copies of our book have been sold during the year under review, which make total sales an even 1,000 copies, of which 990 have been paid for. Gross receipts have been $2,196.99, and gross expenses $2,027.64, leaving net receipts of $169.35.

Sales of our book are now principally due to prior publicity, although prospectus of the book is mailed in answer to inquiries for our publications. Free copies of the book are given to new members and to new magazine subscribers, 27 having been thus used to date. The total number of books distributed is 1,828, and our present stock is 838 copies.

Secretary's Annual Report

HAVING promised members that annual reports would be presented in abstract form, and having already covered routine matters in the report of your Directors, I shall take the opportunity in this, my personal report, to refer to some of our most important actions and activities in more detail.

First, however, allow me to record personally, and also on behalf of the Corporation, our great obligation to those officers, directors and committees of the Institute who gave so largely of their ability and time to the good of the organization during a year when such extraordinary demands were made upon them by business, the N. R. A. codes and other emergency activities.

To our President, and to his active representative in our work, Mr. William W. Buffum, I desire to extend my personal thanks for their valuable advice and unfailing co-operation. I am deeply regretful, however, that the $2,500 that we received from the Chemical Foundation in 1932–33, and that was expended in "complimentary" memberships for the purpose of educating a selected list of 250 non-member textile manufacturers in the value of scientific research and our services, could have been made to pay no greater immediate dividends than in the renewal of only 22½ per cent of this list, and an income from these renewals during the last fiscal year of $1,060.

We may be pardoned for pointing with pride to an increase in paid memberships last year only four less than 100, but, for our failure to approach anywhere near our budgeted figures for contributing members, we have no excuse excepting business conditions and inadequate salesmanship. I hope that during the current year I may have as helpful co-operation in this part of our membership work as was given me last year by Mr. Buffum and Mr. Eavenson.

Institute Publications

Our magazine, TEXTILE RESEARCH, has been declared by many members to be worth to them their full annual dues of $10.' Its actual cost if properly figured is not far from $10 per member and subscriber. It would not be possible for us to publish the magazine without advertising revenue, if it were not for the arrangement with the Textile Foundation by which they pay us an agreed cost price for research reports released to our magazine and published. That so-called "cost price" falls far short of covering the editorial and clerical expense involved. However, the arrangement is mutually advantageous. The Foundation gets its reports published in an acceptable form for less than the service could be provided satisfactorily in any other manner to as large a number of automatically selected readers, and our members and subscribers get a scientific research literature service for much less than cost price.

Your Board of Editors and Publications Committee regret that the magazine in its present scope falls far short of their ideals, particularly in the number of research reports, other than those of the Foundation, that it can afford to publish in any but abstract form, and in the small amount of space available for abstracts. I have on my desk about a two months' supply of unpublished abstracts; their delayed printing is an unfortunate defect in this service.

Without in any manner infringing upon the service performed by other textile publications, each issue of the magazine could advantageously have its published matter increased about fifty per cent. This service can be supplied when the demand, as reflected in a sufficiently increased Institute membership, provides the funds. Meantime, possibly we should congratulate ourselves that we have not been obliged to suspend publication as have so many other research publicatins recently due to high costs and decreased income. As the managing editor of your magazine I desire to record my appreciation of the valuable co-operation that I have received from Prof. Schwarz, as chairman of the Board of Editors and of the Abstracts Committee, and from Mr. Weiss as a member of the latter committee.

The Research Program

Although your Research Committee has no results of its own researches to report at this meeting, I feel confident that it has laid the foundation upon which a resultful program can be builded. First, let me state my belief that the appointment of a so-called Research Council at the Washington meeting last January has been largely responsible for the progress made since then. The members of our Research Committee are widely scattered, are busy men, and find it difficult to attend frequent meetings. A few men who were willing and able to get together more frequently were selected for the Council; they are as follows: Dr. W. E. Emley, Chairman, Dr. H. DeWitt Smith, Vice-Chairman; Alban Eavenson, Fessenden S. Blanchard, Prof. E. R. Schwarz and your Secretary. I was added merely because I have considered it a duty to attend the committee's meetings. It is to the members of this Council that we owe the success of the two research conferences held during the year, and research programs resulting from those conferences that we hope may be equally successful. The Council has assigned to me the job of promoting the co-operative financing of a study of the warp sizing of cotton and synthetic yarns, but I regret to state that

since the last meeting work incident to this meeting and the closing and starting of our fiscal year have allowed me only time to start a letter canvass of those who attended the warp sizing conference last May. This has developed some encouraging results, and several promises of financial support. This will be one of my most important duties during the next few weeks and I shall need and welcome your moral and financial aid.

The American Cotton Manufacturers Association (representing the Southern branch of the cotton industry) and the National Association of Cotton Manufacturers (representing the Northern branch) adopted unanimously at their recent meetings identical platforms of principles of industrial relations. Plank No. 6 of this platform is of particular interest because it records the first united public confession of the domestic cotton textile industry that its survival depends upon scientific research.

Since neither meeting backed up this confession with appropriation of funds that would convert their faith into work, it may be fair to assume that these organizations, many of whose members are also members of U. S. Institute, are expecting existing scientific research bodies to provide the work. As our research council and executive committee have been developing plans to meet just such an emergency I believe that we can assure the cotton textile industry that these plans will be laid before them at the earliest opportunity.

I wish also to call attention to the sales promotion plans that are being considered or developed by the wool industry, the silk industry and the synthetic fibre industry. That the plans of the last-named industry will take full advantage of scientific research is self-evident, for the synthetic fibre industry is an outstanding textile example of fundamental research results scientifically applied, and of the utilization of such research as a necessary tool of industry. (It is not surprising, by the way, that this branch of the textile industry should have a 100 per cent membership in U. S. Institute.) Faced by such competitive publicity it is hardly conceivable that, in the battle of the textile fibres for a share of the consumers' dollars, the silk, the wool and the cotton branches of the industry should fail to make such use of favorable scientific research as is available, or should fail to make a planned program of scientific research a part of their sales promotional plans. We can assure each branch of the industry that in both activities they can depend upon the co-operation of U. S. Institute; and also that the ability of the Institute to co-operate more effectively with them can be ensured by their co-operation within the Institute.

Research Committee's Annual Report

THANKS largely to the addition of two new members, Mr. Alban Eavenson and Dr. H. DeWitt Smith, and the new ideas which they brought with them, this committee has been unusually active during the past year.

Since the inception of the Institute, we have been carrying on our books a list of research problems to be solved if and when the opportunity arrived. A recent survey of the literature indicates that several of these have been undertaken, and some of them solved, by other organizations

which were financially able to do so. While the Institute may not have received due credit in all cases, this is rather immaterial. The industry has benefitted by the results obtained, and we have carried out our purpose of encouraging research work in the textile field.

This year, we decided to select certain problems which seemed to us important, and to ascertain whether or not they are of real importance to the industry. To this end, public hearings on two problems were held at two meetings in New York, in March and May respectively. At the first meeting, on "Wear Testing," more than 60 representatives of the various branches of the industry were present; the attendance at the second meeting, on "Sizing of Warp Yarns," was more than 100. At both meetings the problems were thoroughly analyzed from every point of view, and were enthusiastically endorsed as of interest to the industry.

As a result of the conference on "Wear Testing," it was decided:

(1) That it seems hopeless at present to try to develop a single abrasion test which can be used satisfactorily on all fabrics. That our first efforts should be concentrated on the development of a testing method for a single fabric.

(2) That the adequacy of any test method must be judged by its ability to duplicate the characteristics of the wear which the fabric receives in service.

(3) That women's full-fashioned silk hosiery be selected as the fabric to be investigated first.

(4) That because of the absence of the funds required to put someone on the problem full-time, Dr. H. F. Schiefer be asked to take over the work and do what he can with it, in co-operation with Prof. E. R. Schwarz.

(5) That those interested send samples and descriptions of testing methods to Dr. Schiefer.

To date only a very few samples have been received and Dr. Schiefer has not had time to follow the matter vigorously. It is known, however, that at least four organizations are working on this problem independently.

The lack of progress of this work since the conference is not due to any lack of interest in the industry, but simply emphasizes the need for a full-time man to do the work.

As a result of the conference on the "Sizing of Warp Yarns," a detailed program of research has been prepared. This states exactly what we propose to do, and estimates the cost of doing it. This is now in the hands of Secretary Clark, to be used as the basis for the solicitation of funds.

These conferences have profoundly affected the relations between the Institute and the industry. Each conference cost the industry more than a thousand dollars, merely to cover the time and expenses of the men attending. Having spent this sum in developing a program for research, the industry is under a moral obligation to provide funds to carry out the program. The Institute, having supervised the preparation of the program, is in duty bound to devote every effort to carrying it out.

With these two programs worked out in detail, your committee is ready and anxious to get started. Nothing further can be done without funds. It is estimated that each of the two problems will require $5,000 a year for two or three years.

Use of the Polarizing Microscope in Cotton Classing

By C. L. PATTEE*

For some eighteen months the Pequot Mills, manufacturers of Pequot sheets and pillow cases, Salem, Mass., have been using the polarizing microscope in their cotton classing for positive identification of the presence or absence of immature fibre. The same microscope, with the addition of a disc-micrometer for the eyepiece, is used to measure the ribbon-width or fineness of fibres.

The purpose, results and technique are described by C. L. Pattee, Pequot Mills technician, in the October number of Textile World, and the article is reprinted here in large part. While admitting that this adaptation of scientific research is not perfect, the author states that it is a valuable aid to the cotton classer and buyer in evaluating the character of cotton.

For suggestions leading to this practical application of the polarizing microscope the author gives credit to E. R. Schwarz, associate professor of textile engineering, Massachusetts Institute of Technology, and also prominently identified with U. S. Institute for Textile Research, Inc.

OF the various features in the quality of cotton, "character" is one property which rates very high in importance and which, peculiarly enough, is one of the hardest factors to define accurately.

It is with the assistance of the polarizing microscope that we are to judge more accurately the "character" of the cotton we buy. By utilizing the interference colors displayed by cotton fibres when viewed with polarized light we can go a considerable way toward evaluating the strength and body of a sample.[1] With the addition of a disc-micrometer for the eyepiece, we can have a means of measuring the ribbon-width or fineness of the fibre—another factor which has been recently proved important to the spinnability.

The strength and body of a sample are largely dependent upon the degree of ripeness or maturity of the fibres. The maturity is in turn dependent upon the extent of the development of the so-called secondary portion of the wall. Due to the optical properties of the fibrils that form the framework of this secondary wall, plane-polarized light suffers retardation in passing through these anisotropic particles and assumes definite interference colors. The exact effect is governed by the amount of fibillous layers penetrated by their orientations with respect to the fibre axis, and, inde-

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pendently to a large extent, by the degree of thickening. Inasmuch as the primary or outer wall does not seem to have a highly variable composition or particle-orientation, it exhibits very nearly a fixed color under ordinary conditions. Thus with what we might assume as one variable factor in combination with one fixed component, the amount of change to be recorded in the former can be readily determined.

As early as 1858, cotton fibres were known to be anisotropic (doubly refracting) in nature, and 55 years later the crystallinity of cellulose was first confirmed by means of X-rays. Within the last comparatively few years, considerable has been learned about the differences in the two walls. Balls [2] gives the following physical relationships for Egyptian types:

	Primary Wall	Secondary Wall
Tensile strength	1 gm.	5 gm.
Weight per centimeter	.0005 mg.	.001 mg.
Strength per .001 mg. wgt. per centimeter	2 gm.	5 gm.

From the above figures it is apparent that the development of the secondary wall should be given much consideration if the utmost is desired in yarn and fabric strengths. The mature fibre will also card and spin better and will not have a tendency to nep [3] so quickly in processing. This latter feature will improve the appearance of the yarn or fabric materially, especially if the product is to be dyed, for neps are noted to take on a different shade from the remainder and thus stand out prominently to discourage the manufacturer and buyer alike. The writer has also observed at the Pequot Mills that the action of heat and chemicals in laundering is best withstood by the mature types of fibres.

The apparatus to determine maturity is relatively simple to use and inexpensive—particularly as the first cost is practically the last. The expense of upkeep is almost nothing if the instrument is given even ordinary care. Perhaps the handiest form to the writer is the petrographic microscope, or one having the analyzing prism in the body-tube. To others an instrument having a cap analyzer may perhaps be more suitable. A rotating stage is necessary in either case.

The light source is preferably of fixed intensity and color. Since we are to make color comparisons with known standards, the writer has mounted his microscope on the top of the light source, which in this case is a small box with a work panel included. This box is properly insulated and ventilated to take care of the heat of the incandescent lamp within. A "daylight" diffusing glass gives a truer rendition of the colors, while a velvet-covered work panel, with tray for slides and tweezers, completes the convenience of the unit. A "red of the first order" selenite compensator is used to convert the relatively indistinguishable polarizing colors to hues of more positive identification.

The best set-up has been found to be 100 magnifications—obtained by the use of a 10x objective and a 10x ocular. This combination allows the use of two slides (dispensing with the cover-glass) to hold the specimens and has a large field of view and depth of focus. The prisms are placed at 90° with one another (crossed nicols); and the cross-hairs in the eye-piece, at 45° with the prisms. If the selenite is removed, crossed nicols should give a perfectly black background; and upon replacement of the selenite, the background should become magenta (or red of the first order).

To make a measurement of a sample, about 75 fibres from a classer's "pull" are laid parallel between two slides. In the loading of the slide, make every attempt to prevent bunching-up of the fibres, so that a minimum of time will be spent in the actual counting and evaluating. After a little practice one will be able to lay out the fibres parallel, with remarkable precision. Starting from either side, at approximately the center of the fibres, move the slides slowly across the field and count out exactly 50 fibres in order, using the intersection of the cross-hairs as a point of reference. Stopping on the fiftieth fibre, return to the starting point slowly and evaluate the poorer fibres as follows:

(*a*) Count one point demerit for any fibre having a continuous section 1/10 mm. (about 1/10 of diameter of field of view) or more which is light blue in color.

(*b*) Count two points in the same way for any fibre indigo in color.

(*c*) By subtracting from 100 the total count thus acquired in the examination of the 50 fibres, the "maturity rating" of that particular slide is obtained. If a high degree of accuracy is necessary, repeat this operation twice, each with a new set of fibres from the same "pull." It must be here stressed that the color determination must be made only when the fibre in question is parallel to the cross-hair which lies in the same direction as the arrow on the selenite. If the fibres do not appear parallel as they come into view, the stage must be rotated slightly to bring them so before the determination is made. As to the time consumed in making a rating of three slides, the writer can make a pull, extract and count three slides, and compute the result in from three to four minutes.

The reader who feels that a measurement made from viewing only about one millimeter of a fibre 25 to 30 mm. in length will lead to unreliable results need only follow through from base to tip those fibres which showed only a section colored light-blue or indigo at the first examination. He will observe many repetitions of such a section. It might also be added that, if one examines the point of fracture on fibres of this type, the occurrence of the fracture at a poor section showing indigo, or at a medium section showing light-blue, will be most often observed.

As a check upon the color determination, it will be noticed that fibres showing indigo will, upon 90° rotation, become orange in color. In the same way, light-blue fibres will become yellow. The highly matured fibres, however, will be yellow-green *and will not change color upon rotation.*

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Micro-Analysis of Textile Fibres

Part II.—Observations on the Structure of Ramie

By G. GORDON OSBORNE *

Summary

It is shown by means of a casting technique, and subsequent microscopic examination of the fibre in situ *and after removal from the cast, that many of the familiar markings exhibited by ramie are actually fissures.*

Partial explanation of the known lack of resistance to bending and torsion displayed by the fibre is offered, and certain details of technique of general interest in fibre microscopy are described.

Introduction

TO the minds of many, particularly the manufacturers, the question arises as to why, of all fibres, ramie should be selected as the first vegetable fibre for investigation in this research. From their point-of-view it is a decidedly minor fibre. Any one of a number of others—cotton, flax, jute—is more important from production, manufacturing, and use standpoints. Such is admittedly the case; the use of ramie is narrow, nor is there immediate prospect of a growth in its importance. Nevertheless, its selection is advisable, and rests on the following reasons:

Ramie is naturally one of the purest forms of cellulose. In this respect it has served as the basis for much of the research work on intimate structural detail. Not only chemically, from the standpoint of molecular and micellar arrangement, but also from the aspect of X-ray analysis and physical testing, ramie has been a chief source for experimentation. In this regard the present study is important. Such findings as are made here can be related to those made in other fields. Thus, each will aid the other and lead to a broader understanding of fibre properties.

* Mr. Osborne as a Senior Fellow of the Textile Foundation worked under the direction of Prof. E. R. Schwarz, Massachusetts Institute of Technology, Cambridge, Mass.

Again, not only is ramie purer chemically than many other fibres, but it is also more perfectly arranged. The lining up and degree of departure from parallel arrangement of the fibre have received much attention, and place it as one of the simplest vegetable fibres in respect to structure. Combined with this is its relatively easy working dimensions, especially length. Attention has already been called to the lack of existing methods for fibre study. Ramie serves the double purpose of an experimental material for testing and perfecting technique, and for acquiring scientific knowledge of the fibre. Due to its comparatively simple structure and handling properties it is the first fibre to be attacked. When method and discoveries are completed here, a harder objective will be undertaken, and, with the technique-problems mainly under control, full attention can be centered on the new fibre. Thus progress can be made from simpler beginnings (ramie) through increasingly hard ones (flax, hemp, etc.) to the most difficult and complex of vegetable fibres—cotton.

Little, if anything, is published about the inherent physical characteristics of ramie. There is much dispute and misunderstanding concerning its molecular arrangement, action in polarized light, so-called joint structure, and markings. There seems small doubt that the latter are closely allied with the fibre's known brittleness and inability to stand flexure. The following paper is the beginning of a study of this detailed structure, and its findings are so offered.

Experimental

The first step in the study of ramie was the application of the longitudinal splitting technique.[1] By means of this an inspection and investigation of some of the fibre's major internal characteristics were possible. The length of the fibre facilitates its cutting and mounting; but it is brittle and, once the cut starts, care must be taken to see that it does not go too deep or the fibre will rupture. It is advisable not to sever the shaving completely from the sliced portion of the fibre, but to bend it away from the cut so it may serve as a mark for the section and a means of determining whether the split is in a plane suitable for inspection. When the section is prepared it is mounted in a special microscope-stage yarn holder, and viewed with direct incident light. Thus the interference or diffraction patterns, which come with the use of a dry or air mount in conjunction with transmitted light, are eliminated and erroneous interpretations avoided.

Fig. 1 shows a camera lucida drawing of a split ramie fibre. The beginning of the incision, the side walls, and the central channel are definitely marked. Another split section is also shown. This time the walls, lumen and part of the cut shaving are evident. It would be well to note here, that although the lumen shows up distinctly, both in direct and transmitted light, it does not necessarily follow that it is exposed by the cut. Whether exposed or not, its shadow and outline are prominent, and where the cut has gone below the fibre surface are sufficient to be observed under almost all conditions. However, these illustrations, selected from many, probably show an exposed central channel.

At the bottom of Fig. 1, in both sections, an attempt has been made to record the presence of laminations or "slip spirals." These defects

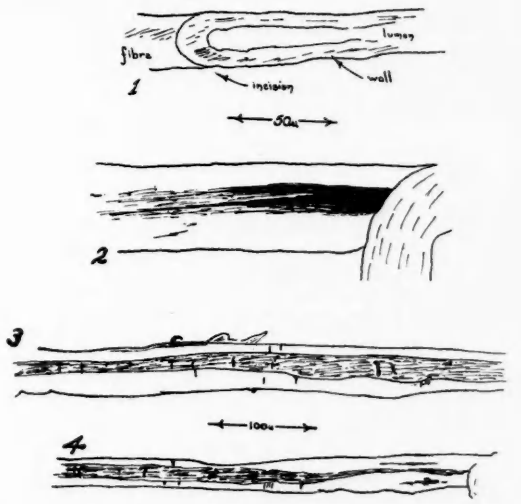

FIG. 1

would appear as dark lines (Fig. 2), running for short distances in the fibre. As illustrated, such lines do show in the specimens and have this expected appearance. In the upper view they are mostly in the central channel, with a few showing through or in the side walls. In the lower view these lines or fractures are heavier and fewer in number, but of the same length and arrangement. Such fractures will tend to lie at right angles to the fibrils of the fibre. This lends weight to the theory that the fibre structure of ramie is nearly parallel to the fibre axis; a conjecture further emphasized by its appearance in polarized light.

Ramie is one of the most difficult of the fibres to cross-section. None of the more simple treatments result in satisfactory sections for this detailed study. Due to its brittleness a more lengthy procedure is necessary. The sections illustrated were obtained as follows: Three fibres of about

equal length were selected and stained with Methyl Green. Their ends were collected and held by gummed paper against the walls of a beaker, while the fibres themselves were suspended in U formation in the collodion it contained. The time of immersion varied from several hours to a full day. When removed, the fibres were stretched tight along a glass slide and a thin layer of collodion flowed over them. Before this collodion was

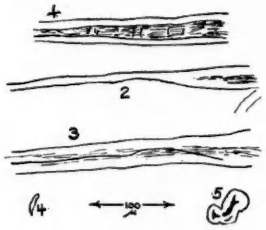

FIG. 2

quite dry, it was trimmed with a razor to as narrow a strip as possible. Then this strip containing the fibres was removed and built up in the regular manner with paraffin.

Fig. 3a shows three ramie cross-sections mounted dry and seen in polarized light. The size and irregularity of the lumen will be noted; also that the ragged leads from the lumen are larger and more intense than the fissures which appear throughout the body of the fibre. Many markings, which may be taken as laminations, run from the surface to the central channel, and some even extend through on the other side. At the ends

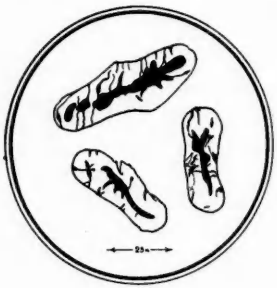

FIG. 3a

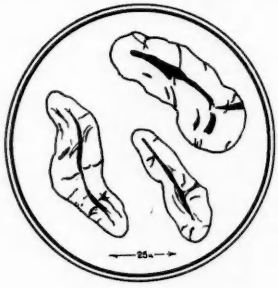

FIG. 3b

there is a tendency for these to completely bound a small section of the outside fibre wall. Whether the impact of the cutting stroke creates or intensifies these markings is not certain, but there is a tendency for them to be concentrated on one side. In these sections there is evidence of small openings, probably continuations of the lumen, as well as some spotting and pitting.

Fig. 3b also shows three ramie cross-sections, this time mounted in balsam. The internal imperfections are not in such contrast here, but are nevertheless numerous. There is less evidence of surface openings, but these are larger. Moreover, they tend to run straight, and not to curve either on themselves or back to another portion of the surface. Internally, there are more holes and pits in the body of the fibre and more short-length fissures. The lumen tends to be longer and narrower and more regular in outline, while the entire body is freer from markings. (See also Figs. 10c and 10d.)

Detail of Technique

To further the investigation concerning the external character of the ramie fibre the following technique was followed: A long, well-laminated ramie fibre was selected under the binocular stereoscopic microscope. This was mounted, as previously described,[1] so that a collodion cast could be taken. The form used was 1¼ × ½ in., as it was desirable to mould as great a fibre length as possible. The collodion was allowed to set three hours, and then the fibre, form and cast were all removed from the slide as a unit. Care was taken to see that the fibre was not pulled from or disturbed in the mount during this removal. The collodion at this stage is plastic. It is smooth and well hardened on the outside and has not begun to curl or shrink. More important, it has not too firmly gripped the embedded fibre which can still be removed fairly easily.

From this point on the work must move rapidly, as all the time that the cast is drying, hardening and becoming distorted, the collodion is gripping the fibre more tightly and is bending and shrinking out of a flat plane, thus making fibre removal and microscopical examination difficult.

The cast is placed, face upward, on a clean slide on the microscope stage. A polarizing microscope was used for a reason to be stated later, and also because plane-polarized light shows the embedded fibre as light with the laminations dark, and with more contrast than is obtainable otherwise. The fibre is examined in a cursory manner and any interesting external appearances, in this case laminations, are noted. The cast is then placed under the binocular stereoscopic microscope and a definite identifying mark is placed against these places, next to the fibre, by means of the small surgical lance. Returning the slide to the high-powered microscope these identifying marks are found and a camera lucida sketch made of the fibre and the mark, as illustrated. It was found advisable for greater precision in matching-up, to bisect the identifying mark, generally a cut or arrow head, by one of the ocular cross-hairs. The cast is once more removed to the binocular stereoscopic microscope and the embedded fibre is removed from the cast, special care being taken to prevent the fibre from breaking at or near the portion sketched. The fibre is then temporarily mounted on a slide for future reference, if necessary, and the observed portion marked. This later examination of the fibre has not been very successful. It is difficult to orient the fibre as it was in the cast, and a comparison drawing is hard to get. Moreover, the first drawing is an actual sketch of the fibre *in situ* and is, therefore, all that is needed.

Now the actual cast, vacant of fibre, is placed in position for sketching. The same portion is observed under the same conditions and when the sketch is complete it is compared with the original one containing the fibre. Marks appearing in the cast must be surface or external in nature. Marks

appearing in the original sketch of the fibre, but not in the sketch of the cast, are either internal in origin or have failed to register in the collodion.

Each event in this sequence is as a link in a chain leading to the final result. Any mistake, such as fibre rupture, a spoiled cast, a slip on the identifying arrangement, etc., will make valueless all the work preceding it. As the process is lengthy, the cast alone taking three hours, great care must be taken to insure the following out of the technique with dispatch. The chief difficulties lie in the cast, and are its removal from the slide and the removal of the fibre. Care here is imperative and if the directions already given [1] are followed a good number of successes should result.

Nature of Markings

The first drawing in the upper half of Fig. 4 is a drawing of the collodion-embedded ramie fibre. The shade and shadow detail has been added to give the appearance of the actual mount, but is not needed, and can be omitted. Point "A" is the identifying mark, placed at one of the "joints" of the fibre, which occupies the distance "J." This is shown in polarized light, both in the cast and without, to consist of a mass of irregularly oriented trans-fibre fissures ("crossings"), and light and dark places. There appears to be a difference between this portion "J" and a simple fissure such as "L." The drawing below it (Diagram 2) is the same sketch as Diagram 1 with the fibre removed. It will be noticed that the joint markings are not evident, but that simple trans-fibre fissures as "L" are seen. These are obviously on the outside or surface of the fibre.

Individual fissures do not follow the same shape, shading or position in each sketch. The latter two are inconsequential; change in position is very slight and is probably due to change in the direction of lighting, focus, etc., while change in appearance (shading) is to be expected, due to the removal of the actual fibre. The change in size and shape of the trans-fibre fissures is more decided; very few of these are the same. A part of this change is also due to changes in the adjustments of the microscope. Part is probably due to unobserved and unrecorded detail; part to the personal equation in making the camera lucida sketches; and part to the fact that structural character in one view is hidden in the other, and vice-versa. In this respect it will be noted that several of the illustrations of casts show details not recorded in the fibre view; these in all probability were there but were not evident. There is a possibility that some unduplicated marks are due to diffraction and interference effects or to the influence of the torn and broken edges of the lower surface of the cast through which the fibre was withdrawn. Great care was taken, however, to guard against this. Details that appear in the fibre sketch and not in the cast may be explained as interior markings, or to structure on the lower sides or bottom of the fibre, evidence of which is lost through destruction when the fibre is removed. In this respect it is to be noted that any change of focus was minimized, although it was occasionally necessary when the focus at the top of the specimen failed to show clearly important outlines.

To return to the camera lucida drawings; the general appearance and position of certain trans-fibre fissures in both sketches point to the fact that they are the same. Thus in Diagram 1 trans-fibre fissures a, b, c, may be considered to be the same as those so lettered in Diagram 2. The position as measured from the reference point "A" is identical, and the gen-

eral size and shape are fairly similar. Lines x–x represent the central canal or lumen, and x_1—x_1 the fissure resulting from fibre withdrawal.

The lower half of Fig. 4 shows two diagrams similar to the ones described above and with the same notations. Here the reference points are

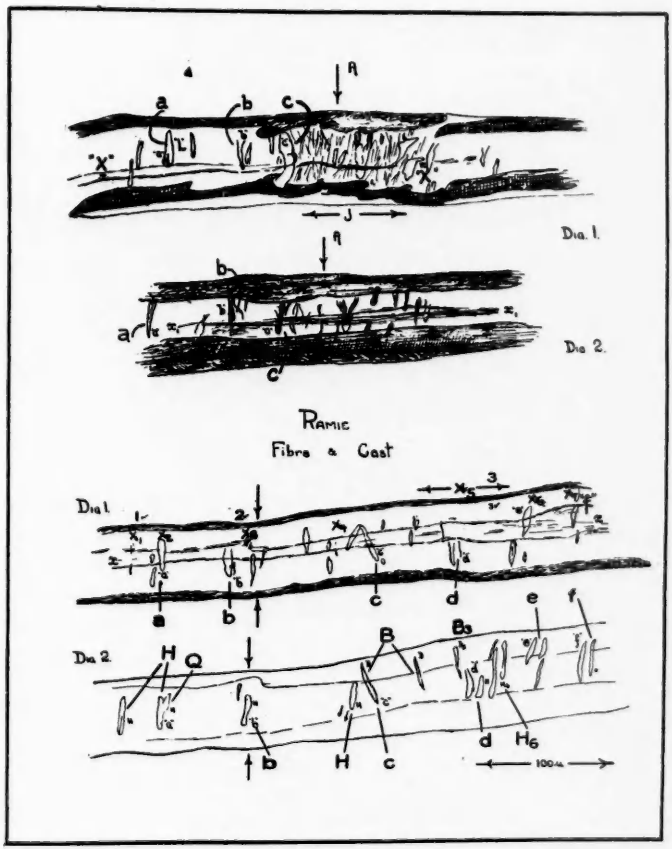

FIG. 4

shown by arrows, and trans-fibre fissures which may be considered the same are so lettered. To further test the accuracy of the first drawing the analyzer was brought into action after the sketch was completed in plane-polarized light. The small "x" indicates trans-fibre fissures that

show up strongly in polarized light; the fibre being in a position of extinction. There are seven positions so marked; x_1 was not drawn in as it was at the edge of the field; x_4 was very bright but was so complicated that the major portion of it was left unsketched, as was x_5 which covered such an area (as shown by the arrow) as to warrant omission, and x_6 is also interesting as it definitely extended from the top to the bottom of the fibre. The three check marks (✓) indicate "joints."

In Diagram 4 the marks that stood out most clearly have been marked with an H. The marks that were on the lower sides or bottom of the cast are lettered B. The B's were recorded when a lowering of focus was necessary in order to bring a strong imprint into sharp outline; that they are not due to a dip or bend in the cast itself is evidenced by the closeness of B_3 to H_3. In these illustrations, which correlate most closely, there is strong evidence to show that the trans-fibre fissures similarly lettered (six in all) are truly similar, and that there is considerable surface marking and pitting or cracking on the outside of the ramie fibre.

Internal Fissures

Fig. 5 was obtained from the cast of a portion of the fibre that had been longitudinally split beforehand. The cast is placed under the binocular stereoscopic microscope and the fibre pulled from the collodion until a very short length has passed the identifying mark. The fibre is then stretched out, back along the cast, and marked at the correct place either by a stain or by sticking another fibre cross-wise to it. After this the fibre is completely removed and mounted in the jaws of the rotary manipulator.[1] It is then oriented so that it assumes the same position as it had in the collodion where it is sketched and checked, as are the other views. Care must be taken with the manipulation to get the fibre as accurately oriented as possible, to preserve it from damage and to observe the identical place previously recorded. This is a painstaking and exacting routine. Thus in each illustration Diagram 1 represents the fibre in the collodion with the split portion turned uppermost, while Diagram 2 is the cast of this exposed split inner section. The trans-fibre fissures, therefore, in both views are seen on or through an inner portion of the fibre.

In the same manner as before, we can deduce that trans-fibre fissures, or cross-markings, that are common to both views must have at least some outlet or opening on the plane exposed to the embedding medium. Therefore, in the case of split sections, if the same trans-fibre fissures appear in the cast as in the fibre we can conclude that their opening was to some degree internal. It would be desirable to find definitely whether these openings or breaks lead into or from the central channel. This, however, would require a very exact splitting of the fibre so as to leave the lumen exposed, a feat that can be accomplised only through chance; the striking of the very narrow passage being too difficult to accomplish except at random. Nevertheless, it is very possible to expect that there are internal openings on the lumen, and this should be confirmed by a study of the cross-section.

Referring to the first diagram of Fig. 5, the embedded fibre shows clear cross-markings at a, b, and d and complicated markings at c. The central channel has been indicated by the heavy lines c–c, while the heavy shading at the top is shadow. The arrow in both cases indicates the reference

point, in this case the end of the split shaving. The exposed inner surface is the entire part sketched. In the cast there is close correlation as regards the position of the trans-fibre fissures, and fair correlations as to shape and size. Fissures that may be regarded as similar are so indicated. It will also be noted that there is an even closer correlation between the free spaces or the area between the markings.

That this was one of the chance times that the central channel was exposed in splitting was felt, not only by the appearance of the fibre before and after embedding, but also by measurements with the fine focussing adjustment of the microscope of its relative position as compared

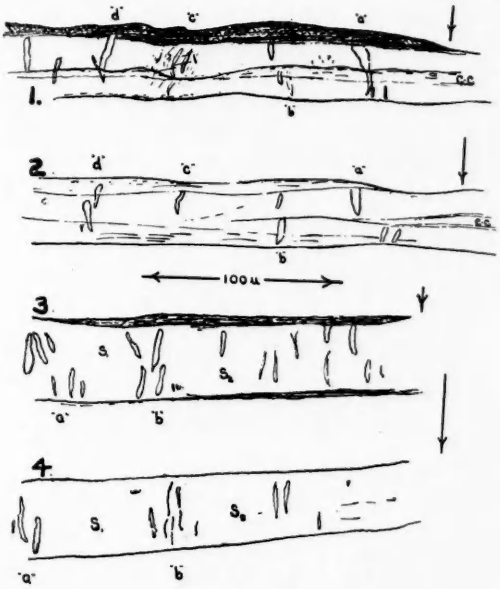

FIG. 5

with its other parts. Thus, the sharpest focus of the central channel was found at the top of the adjustment. Lowering the focus would bring the sides and bottom of the fibre into clear outline, as well as the top of the slide, but the area e–e would blur. The interesting point is that there was no indication of a trans-fibre fissure in this area in the cast, and only a very small mark of this sort in the fibre. That the latter is not the usual condition is attested by numerous previous drawings. In the cast, the opening of the lumen may have been so small as to exclude the collodion, or, if it penetrated, may have been retained when the fibre was removed.

The lower half of Fig. 5 shows a similar split fibre. The correlation here is fairly good. Diagram 3 shows a section of fibre closely marked with trans-fibre fissures, many of which are very fine. The larger trans-fibre fissures are reproduced in the cast, but the fine ones do not appear. This lends support to the theory that, unless the lamination offers an opening of sufficient breadth, the collodion does not enter and leave its impression. Also, that a difference in size of the recorded laminations may be due to only partial filling of surface openings. It will be noticed that the trans-fibre fissure marks in the cast always tend to be smaller than the corresponding ones in the fibre.

Relation of Cast Record to Fibre Surface

The possibilities that this casting method may not give quite the exact conditions in respect to the shape of the fissures are as follows and are best illustrated by the diagrams of Fig. 6: Diagram 1 shows what might be considered the ideal case. Here there is no reason why the fibre and cast should not show exactly the same results. Thus the opening seen in the fibre (F) would be congruent to that in the cast (C). (F = C).

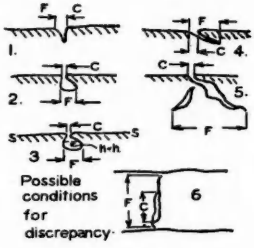

FIG. 6

Diagram 2 shows a change in the size of the crack. In the fibre the opening would appear as width F; in the cast as C; or, if the opening was so small as to exclude all casting material, no sign would appear in the cast. Even if the medium entirely fills the cavity, the appearance in the cast depends on how or whether the removal of the fibre affects the mould. If it is completely unaltered by removal, F and C will be the same. If it is broken off at the surface (line s–s, Diagram 3) nothing will show in the cast. While if it is broken at h–h, the cast will show an impression half as wide as the mark in the fibre. Diagram 4 illustrates another form in which the cast fissure may differ from (be smaller than) that in the fibre. The medium may fail either to completely penetrate the fault or to hold upon fibre removal. Diagram 5 represents what may actually be the condition in many instances. Here the fibre would give, apparently, a very wide trans-fibre fissure, F, while the cast would show a small one, C. The same case also exists relative to the length of the fissures, as per Diagram 6. This lends weight to the contention that a close correlation between the position of the marks in fibre and cast is more important than correlation between shape and size.

That the moulding medium might distort these fissures, and increase their actual size by expanding or swelling, has not been experienced, nor is it likely due to the nature of the liquids employed.

It would be interesting, if possible, to further examine the nature of the size, form and position of these fissures. For, even if nothing definite is obtained, it will influence the interpretation of the casts just discussed and help in the construction of a diagrammatic sketch of the fibre. To do this a ramie fibre was mounted in the rotary manipulator so that one jaw gripped the fibre in a well-marked place. The microscopic inspection was with polarized light using a low-powered objective. This was necessary in order to have a working distance great enough for jaw revolution. The end of the jaw served as a reference line.

By rotating the jaw, and applying sufficient tension, the wide side of the fibre was brought uppermost. The stage was then revolved until the body of the fibre became extinct, when a careful recording of the trans-fibre fissures was made with the camera lucida. Next, the analyzer was withdrawn and the fissures and fibre outline checked in plane-polarized light from the polarizer.

This illustration is shown as Diagram 1 of Fig. 7. By rotating the jaws of the manipulator, the fibre was turned through exactly 180°, thus presenting for inspection what was previously its lower side. The same procedure concerning the camera lucida sketch was followed, the result being shown in Diagram 2. In comparing these two figures it will be seen that many of the fissures, in fact, most of them, are common to both views. These have been so indicated, and shape, size and position show that a, b, c and d are undoubtedly the same. Of course, rotation through 180° inverts the fibre, but a comparison along lines T and U will show an almost perfect similarity.

This does not necessarily mean that a fissure extends completely through the fibre from top to bottom. It merely shows that the same fissures can be seen from both sides. However, as they can be seen almost equally well from both sides, apparently there is a tendency for them to penetrate a considerable part of the fibre.

A similar condition, perhaps even more perfectly matching, is shown in Diagrams 4 and 5. Here it is clearly evident that the marks recorded come from the same source.

Diagram 3 of Fig. 7 is a sketch of the same fibre as shown in Diagrams 1 and 2, but now it has been split longitudinally. This was done by removing it from the rotator and splitting it through the inspected portion, which had been careful identified. On remounting in the rotator, the fibre was aligned so that the cut plane (inner surface) showed uppermost. The camera lucida sketch was made under the same conditions as the previous two.

The cross-markings are very different here as compared with the originals. There is no definite sign of similarity, except in respect to position. On this basis A, C and D have been so lettered as possibly corresponding to a, c and d in Diagrams 1 and 2. That this is probable becomes more apparent on remembering that the section discussed is split. That the width of the fibre, as well as the thickness, has been decreased is obvious. This shortening in width might well have removed some of the length of the two fissures at a. The "A" fissures are shorter and broader, but in exactly the same position and running in the same direction. To a lesser extent the same could be said of C. It is not altogether unlikely, then,

that Diagram 3 represents at least something of Diagrams 1 and 2. A similar sketch to that of Diagram 3 should have been made with the longitudinal split-section rotated through 180°, but, before the drawing could be started, the fibre ruptured. However, merely visual inspection substantiated previous findings in that the omitted figure seemed to bear the same resemblance to Diagram 3 as Diagram 2 does to Diagram 1.

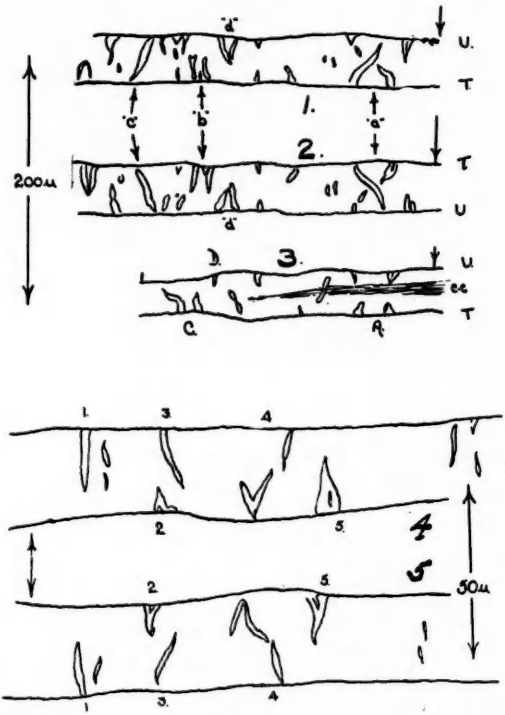

FIG. 7

This evidence points to the contention that trans-fibre fissures, although tending to appear as running uniformly along one definite plane, actually do not. Rather, they change shape, size, and angle of penetration along their course in the fibre, as represented at Diagram 5, Fig. 6.

Discussion

Ramie is the fibre which exhibits the greatest uniformity of structure.[2, 3] Its composition is almost pure cellulose. Yet, although it has been the basis of much study and investigation, there is still considerable

disagreement and misunderstanding concerning its make up. No published work has been found dealing with its external physical characteristics, and the present research may aid in the development of a clearer understanding of the subject.

It is well known that ramie shows the most perfect lining up of its component parts (fibrillae, micelles, and/or molecules) of any of the natural vegetable or animal fibres. This is evidenced when the fibre is inspected in polarized light. Positions of maximum brilliance are obtainel when the fibre is at 45° to the planes of the nicols, the nicols being crossed, while the body of the fibre displays almost complete extinction when in a parallel position. In this latter state the well known and easily recognized striations or trans-fibre fissures are most prominent. They appear as brightly shining marks or cracks of light extending across the fibre and tending to be at right angles to its length. Here it is interesting to note that Dr. Alois Herzog,[4] in his classification of fibres according to their orientation, gives the following: Wool, silk and artificial silk have an orientation parallel to the fibre axis. The orientation of hemp and jute is to the right. That of cotton and mercerized cotton is at random, while flax and ramie is oriented to the left.

Very recently, by the use of selanite plates and very high magnifications, the fact that these cross-markings have definite parallel extinction was demonstrated. These markings have a very close resemblance to the diagrams of Fig. 6.

Definite information of the comparative lining-up of the body of the fibre is given not only by polarized light but also by X-ray analysis.[5] Eckling and Vratky,[6] who carried X-ray analysis also to the cross-section of the fibre, could find no evidence of a definitely higher orientation such as radial or concentric arrangement. Nodder,[7] however, in his work for the Linen Industry Research Association finds that, for ramie, the fibrillar structure is always arranged in left-hand spirals, and that ramie, like flax, will always twist counter-clockwise when dampened and in a clockwise direction when drying. For our purpose, nevertheless, ramie can rightly be considered one of the simplest and least complex of fibres.

It has been calculated[3] that if the structure of cellulose fibres was ideally arranged, so as to form a bundle of principle valence chains which extend throughout the length of the fibre without break or imperfection, the theoretical strength would be about 650 kg/sq.mm. This is several times the strength of the strongest and best oriented natural fibre as given by Meyer and Mark.[3] Ramie is one of the strongest fibres when subject to straight tension, but its brittleness, lack of resistance to flexing and low extensibility, make it an extremely poor fibre for most commercial uses. This study has revealed a possible explanation of its behavior and a means of understanding some of its properties.

The first two diagrams of Fig. 8 are enlarged camera lucida drawings. Diagram 1 shows a ramie fibre embedded in collodion. Diagram 2 shows the cast of this fibre. The trans-fibre fissurings shown in this cast have surface openings. They have been labelled in small letters from "a" to "i," while two groups or markings are lettered "x" and "y" respectively. Trans-fibre fissures in Diagram 1 that, on account of the correlation of their size, shape, and position, can be said to be the cause of those in Diagram 2, are similarly lettered but in capitals. The remaining marks are numbered from 1 to 13.

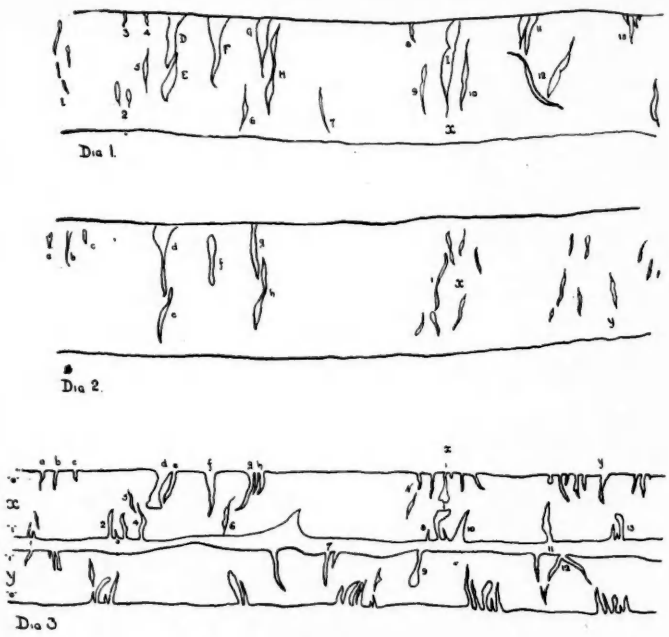

FIG. 8

Possible Structure

With the explanation previously given, and the following assumption, Diagram 3, a schematic, diagrammatic figure of a ramie fibre can be drawn. This diagram is a sectional view of a ramie fibre as interpreted by the findings to-date. The assumption made is that all the fissures shown in Diagrams 1 and 2 act in the same lateral section of Diagram 3, and, though this is not the case, representing it as such saves numerous other drawings similar to 3, and only makes more apparent the degree of imperfection.

Diagram 2 represents the cast of the top half of the fibre. All laminations recorded by it are surface marks; therefore all these will appear in the upper half of Diagram 3, on the outside of the fibre; to be specific, in position "X" "o." Thus laminations "a" to "h" and groups "x" and "y" are so shown and lettered. The fissures appearing in Diagram 1, not corresponding to any in Diagram 2, can be said to have no surface connection and are internal. Their relative degree and position internally are not known. In Diagram 3 they might appear anywhere except on the upper outside surface "X" "o." However, the chance that they have surface openings on the lower side (the portion of the cast destroyed by

fibre withdrawal) is small, and, therefore, none appear in the lower outside section of Diagram 3, "Y" "o." They take their place in parts "X" "i" and "Y" "i" and are numbered as in Diagram 1. The lumen has been drawn in to scale, and most of the internal markings proceed from it. Much of the basis for the position, shape and spacing of these markings is not given in the report, but comes from close microscopic study of many types of fibre mounts. The fissurings in "Y" "o" have no connection with Diagrams 1 or 2, but are arranged to correlate as naturally as possible with the rest of the figure.

The diagram of Fig. 9 is the final conception of a ramie fibre in lateral section. At once, explanations of some of the characteristics pertaining to ramie are apparent. Thus, a possible reason for the large actual reduction in strength from the calculated theoretical is that in breaking the rupture is not across the full diameter of the fibre, or any great part of it, but across one of the shortest distances between the ends of complimentary long striations. In some cases this would reduce the linear distance to be severed by several hundred percent. Again, these penetrating cracks aid bending or flexive failure. There is a high concentration of stress at the edge of the crevice, where the elastic limit is quickly

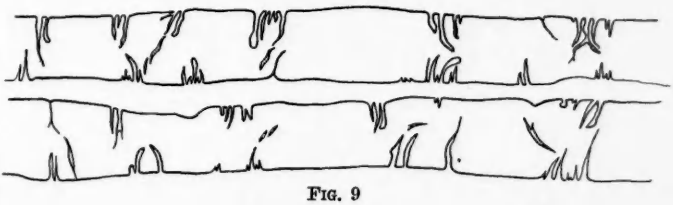

FIG. 9

reached. This would result in a tearing rupture which would require a much lower force than a simultaneous rupture across the whole cross-section.[8] The form and position of these trans-fibre fissures also explain to large measure the lack of extensibility and flexibility of ramie. If the fibre were not so riddled with imperfections, it undoubtedly would be much stronger in all departments.

There have been numerous explanations of the formation of these fissures offered. Balls[9] has advanced the theory for cotton fibres, that the "slip planes" are due to mechanical action, and further that they tend to occur at right angles to the fibrils composing the fibre. Another contention[10] as to the origin of these "dislocation marks" (Verschiebungen) is that the cellulose is subjected to a local pressure which produces in it a change accompanied by the absorption of water and consequent swelling; the markings being due to the occurrence of an increase in volume too sudden to be taken up evenly. Other reasonings suggest a difference in chemical composition between the fibre body and cross-marking; a fault or gap in the chain structure of the molecules; or irregularities and lack of symmetry in micelle arrangement.

It is for the physicist to explain the sub-microscopic structure of the fibre. This investigation is concerned with the discovery that these markings exist as open faults in the fibre, both internally and externally. Un-

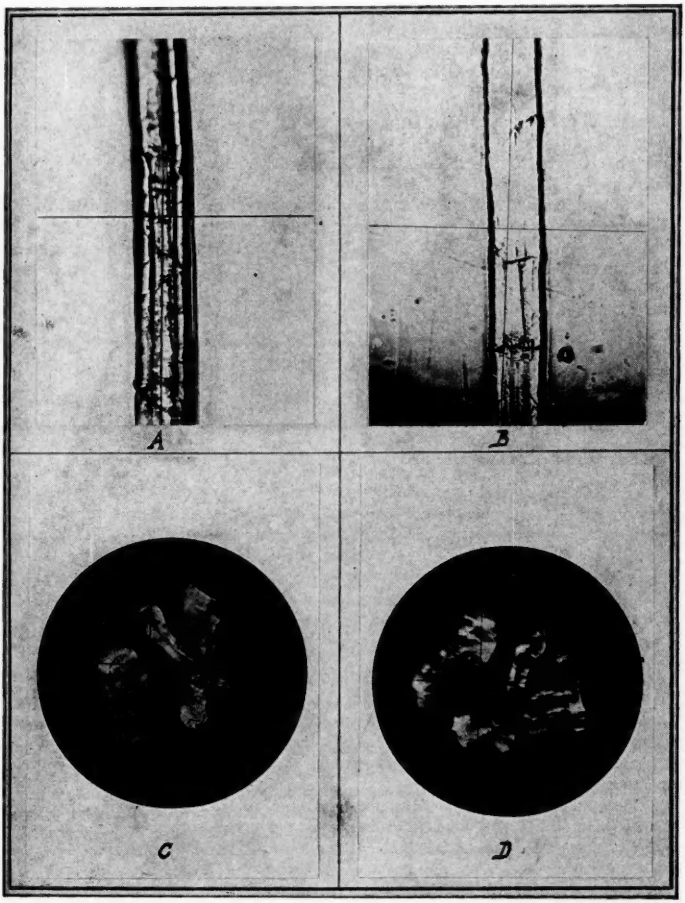

FIG. 10. A. Ramie Fibre in collodion cast. B. Collodion cast-fibre removed. C. Ramie cross-sections—brilliant position. D. Ramie cross-sections—extinct position.

doubtedly they come at places of weakness, whatever their cause. If due to micelle arrangement, it may be at a juncture of micelle ends, which, giving a butt-to-butt effect, would lack the strength and cohesion of the stagger arrangement of the micelles as given by Mark.[11] Further, the mechanical-action theory bears weight; for the fibre used in the experi-

ments had been bleached, carded and combed; all harsh treatments. A fibre fresh from the plant and untreated might show little if any crosswise formation. Mechanical action starts and intensifies the formation of these markings and, as treatment proceeds, the number of the trans-fibre fissures increases.

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A Scientific Study of Warp Sizing

A plan for the scientific study of warp sizing has been prepared by the Institute's Research Council, that is based in large part upon the findings and recommendations of the conference on this subject held by the Institute in New York City last May. This study is to be financed co-operatively, and participation will be confined to a group of not more than 50. This group will receive confidential progress reports prior to publication of the final results, and will qualify for other important privileges. Invitations to join the group have been mailed to those who participated in the New York conference, and will later be addressed to others who should be interested. Secretary Clark has charge of the latter work, and will be glad to mail a prospectus of the plan to inquirers, pending completion of the group.

Silk Degumming

I. Degradation of Silk Sericin by Alkalies

By ROY H. WALTERS* and O. A. HOUGEN†

Abstract

The chemical properties of sericin are reviewed. When alkalies or soap react upon sericin a progressive degradation of the sericin particle takes place in solution after the sericin leaves the silk. The grams of sericin combining with one gram equivalent of soap or alkali when a point of equivalence is attained in solution may be expressed by the equation

$$B = -1000 \log_{10} R - 2180$$

where B *is the binding weight of sericin*

R *is the initial ratio of gram equivalents of total soap or alkali per gram of total sericin initially present.*

This same relationship holds for solutions of sodium hydroxide, sodium carbonate, sodium silicate and sodium oleate for values of B from 140 to 2100, the experimental range. The point of equivalence is taken as neutrality with phenolphthalein when the sericin solution is titrated with standard sodium hydroxide or sulphuric acid in a 40% alcoholic solution. At this point of equivalence sodium-sericin still possesses degumming power so that the values of B just noted do not apply to the binding weight or sericin as it is just removed from the silk.

Introduction

IN the removal of sericin from raw silk by hot alkaline solutions the active alkali content of the bath is lowered by its reaction with sericin to form an alkali-sericin compound of indefinite composition.

In addition to the formation of an alkali-sericin compound the usual products of neutralization result; such as water from sodium hydroxide, free fatty acids from soap solutions,[2, 6] carbonic acid from sodium carbonate and silicic acid from sodium

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silicate. As stated, the composition of this alkali-sericin compound is known to be indefinite and to depend upon the manner of its formation.

It was the object of this investigation to find out the factors which determine the ratio of alkali combined with sericin at the point of equivalence. This ratio will be referred to as the binding weight of sericin, and will be defined as the grams of sericin combined with one gram equivalent of alkali at the point of equivalence. From a theoretical standpoint this information will throw light upon the mechanism whereby the sericin particle reacts with alkalies.

Chemical Nature of Sericin

Sericin as it exists on raw silk is not a single protein. Kondo,[9] and Anderlini,[1] both separated sericin into distinct fractions. Shelton and Johnson [20] definitely established the presence of two proteins which they named Sericin A and Sericin B. Kaneko [7] states that the physical structure of these two sericins are unlike; the A modification appears as anisotropic crystalline micelles whereas the B form is amorphous. When an aqueous solution of sericin is adjusted to a pH of 4.1, sericin B is precipitated, but not the A fraction. The isoelectric point of sericin A is given as a pH of 3.8, and of sericin B as 4.5.[7] Harris [5] gives the isoelectric point of sericin as 3.6 to 3.8. Mosher [14] analyzed sericin from fifty different silks and found that for Japanese silks the content of sericin A varied from 14 to 28%. He also found that sericin B was the valuable substance present in boil-off liquors. Because of its excellent dispersive and penetrating properties it produced level dyeing, acting as a reservoir for dyestuff which was then slowly and evenly supplied to the fabric. In this respect sericin A is valueless. By the action of strong alkalies, or by prolonged heating in water at temperatures above the normal boiling-point, sericin B is gradually converted into the A modification.[14]

Sericin is an albuminoid protein insoluble in cold water. Like all proteins sericin may be broken down into various amino acids of which at least 12 have been isolated, alanin, tyrosin, glycocoll and leucin being the most abundant.[14] The empirical composition of sericin is given as C_{15} H_{25} N_5 O_8.[4] Sericin may be completley dissolved by acid solutions having a pH below 2.5 and by alkali solutions having a pH above 9.5.[10] Many aqueous salt solutions have a strong peptizing action on sericin, due to adsorption of ions, followed by dispersion of like charged particles and finally stabilization by hydration. Harris [5] lists the order of solubility of sericin in salt solutions. Other physico-chemical properties are given by Kodama [8] and Kaneko.[7] The chemical compositions of sericin from many silks are given by Mullin.[15]

At temperatures above 200° F. water slowly peptizes sericin and a colloidal dispersion results. When a sodium hydroxide solution is added to this dispersoid chemical reaction takes place and sodium-sericin plus water are formed. The resultant sodium-sericin is hydrolyzed so that at equivalence with NaOH the equilibrium pH is about 9.8 in .005 N. solution. In

this respect sericin behaves as does oleic acid; in the latter case neutralization with sodium hydroxide gives a soap solution which at equivalence has a pH between 9 and 10. Direct titration of oleic acid in aqueous solution with alkali is unsatisfactory because of the insolubility of oleic acid in water, the colloidal nature of the soap formed and the hydrolysis of this soap. To overcome these difficulties the titrations are conducted in a 40% alcoholic solution wherein the oleic acid is soluble, a true solution of soap results and hydrolysis is repressed. When titrated in an alcoholic solution of 40% concentration the end point at equivalence can be detected by the use of phenolphthalein as an indicator, provided the titrations are carried on with a strong base such as sodium or potassium hydroxides. In a like manner aqueous solutions of sericin can be titrated. In these experiments the binding weight of sericin was established by titration with a standard NaOH solution in a 40% alcohol solution using phenolphthalein as the indicator. It will be found, however, that sericin is very much unlike oleic acid in that no constant value of binding weight is secured, but rather a value which depends upon how the sericin dispersion has been made. When sericin was peptized from raw silk by hot distilled water, and then titrated in 40% alcoholic solution with standard sodium hydroxide, a binding weight of 2100 was obtained. This value seems to be constant regardless of the time of heating or the fraction of sericin removed. When, however, only a part of the sericin was removed from silk by the use of alkaline solutions and the resulting solution titrated to equivalence with additional standard alkali, it was found that the binding weight obtained varied with the pH of the solution, with the nature of the alkali and with the ratio of alkali to sericin initially present in the bath.

Previous Work

Despite the great amount of theoretical work done upon the degumming of silk by alkalies little data seem available concerning the binding weight of sericin towards alkalies. Kodama[8] determined the alkali bound by sericin or its degradation products by measuring the reduction in hydroxyl ion concentration of a standard sodium hydroxide solution when a definite weight of sericin was dissolved therein. This procedure is satisfactory provided a strong base is used and provided the change in pH is large. This method can also be employed for measuring binding weights, provided enough alkali is used to equal or exceed the point of equivalence which occurs at a pH of about 9.8 when sericin is neutralized with 0.005 N NaOH. On this basis the following values of binding weight were calculated from Kodama's data:

Initial gram equivalents of NaOH per gram of Sericin	Equilibrium pH	Binding Weight
.00915	12.7	282
.005	12.3	324
.0025	11.6	490
.0020	11.5	595
.00125	10.7	835

Binding weights cannot be calculated from Kodama's data for concentration ratios lower than .001 because the binding capacity of the sericin had not been attained when these low ratios were employed.

The values of binding weight obtained from Kodama's data do not apply to sericin as it exists on raw silk. Kodama performed his experiments with a sericin which had been extracted from raw silk by hot water, subsequently separated into two fractions with acetic acid at the isoelectric point of sericin, namely pH 3.9. The insoluble portion was then washed with boiling 25% alcohol and dried to a powder with alcohol and ether. The sericin was redissolved in ammonium hydroxide, reprecipitated and dried as before. These various operations profoundly alter the properties of sericin from those possessed by the raw silk. Kodama himself showed that by varying the extraction temperature of sericin with water from 100 to 105° C. the acetic acid precipitate decreased from 100% to 12%. Hart [5] states that the combining weight of sericin is of the same order as a fatty acid but gives no support to this statement. Takahashi [22] shows how the alkali bound by sericin increases with the alkali concentration, but insufficient data are reported in his paper to enable calculations of binding weights to be made.

Wolf [23] measured the binding weight of sericin extracted from both white and yellow Japanese silks. His measurements were made on extracted sericin and hence do not apply with any assurance to sericin as it exists on raw silk. Samples of sericin were dissolved in a standard solution of sodium hydroxide and then back-titrated potentiometrically with standard sulphuric acid. Taking the equivalence point at a pH of 9.8 the following values were obtained:

Initial gram equivalents of alkali per gram of sericin	Binding Weight of Sericin pH 7.0	pH 9.8	
0.00400	340	250	(Yellow Silk)
0.00328	378	304	(Yellow Silk)
0.00270	569	370	(White Silk)
0.00260	570	384	(White Silk)

Potentiometric titrations were also made with sericin dissolved in sodium carbonate and in soap solutions, but the equivalence point is difficult to determine because of the buffering action of the weak acids liberated when back-titrated with standard sulphuric acid. The measurements of pH are subject to considerable error because of the rapid poisoning of the hydrogen-platinum electrode in protein solutions. Wolf also conducted titrations of sericin-alkali solutions by titrating in 40% alcoholic solutions with standard acid using phenolphthalein as an indicator. The following values were obtained:

Initial Gram equivalents of Alkali per gram of Sericin	Binding Weight	
.00231 (KOH)	433	(from White sericin)
.00558 (Na_2CO_3)	179	(from White sericin)
.00176 (KOH)	569	(from Yellow sericin)
.00653 (Na_2CO_3)	153	(from Yellow sericin)

Whether the action of alkali with sericin is chemical or absorptive is debatable. Some state that the action is chemical and determined by the valence forces of free acid groups on sericin; others claim that sericin forms a lyophyllic colloidal system and that ionic interchange is due to

the forces of adsorption characteristic of lyophyllic colloid interfaces. T. R. Robertson [17] states that as the proportion of base to protein declines the binding power of the protein decreases. The binding power increases with increasing alkali concentartion due to the progressive splitting of the protein molecule and not because of decreasing hydrolytic dissociation. Furthermore, he states that at neutrality the binding power is the same regardless of dilution and depends only upon the relative concentration of protein and base.

Experimental Procedure

For practical purposes the binding weight of sericin towards alkalies should properly be established with sericin as it actually exists on raw silk. The preparation of sericin by extraction methods and subsequent recovery as a separate solid invariably results in serious alterations of its properties. The binding weight of sericin cannot be established by simply measuring the alkalli consumption when a known amount of sericin is removed, because of the peptizing action of hot water and because equilibrium conditions must be established. In degumming, both chemical reaction and peptization proceed simultaneously and considerable time is required to establish equilibrium conditions. The procedure actually followed was to degum for two hours with an alkaline solution at the normal boiling-point, using insufficient alkali to completely remove all the sericin. The resultant solution was then brought to equivalence with standard alkali to react with the sericin removed by peptization.

Experiments were carried out with single thread skeins of 13/15 denier raw white Japanese silk, weighing about one-third gram each. Three skeins were used for each test. To each gram of raw silk exactly 100 grams of degumming solution were added. Degumming was carried out in wide-mouth narrow assay flasks of 500 cc. capacity attached to reflux condensers. The average moisture content of the raw silk was determined upon separate samples by the usual procedure of air-drying for two hours at 105° C. Such samples were not used in degumming tests because of the probable alteration of sericin by heating to 105° C. The skeins were opened and wrapped around nickel-wire forms so as to permit ready and even action of the solution. The flasks containing the weighed amount of boil-off solution were placed upon an electric hot plate and attached to a surface reflux condenser in order to maintain a constant amount of water in the flask. When the solution reached the boiling-point the weighed skeins of raw silk on the wire holder were dropped into the flask. Treatment was continued at the boiling-point for exactly two hours, in which time equilibrium within the flask was attained. The pH of the solution was measured at 20° C. before use and after the two-hour test. These measurements were made with a standard Leeds and Northrup glass electrode apparatus used in conjunction with a highly sensitive galvanometer.

Immediately after the two-hour treatment the partially degummed silk samples were rinsed three times with distilled water and the rinse waters combined with the spent boil-off liquor. The combined liquor was diluted with 95% ethyl alcohol to a 40% alcohol concentration and then titrated at 20° C. with standard 0.005 N NaOH using phenolphthalein as the indicator. The partially degummed silk was further rinsed seven times with cold distilled water by alternate squeezing and soaking in the running water and rinsed once finally with 95% alcohol, when soap had been used

in degumming, to remove any residual soap. The samples were air-dried at 20° C. and then in an oven for two hours at 105° C. The dried silk was weighed directly in the drying oven. The residual sericin in the silk was then completely removed by boiling for one hour in a 1% sodium oleate solution. The completely degummed skeins were rinsed 10 times in running distilled water and once in 95% alcohol as before. The dry weight of the completely degummed silk was measured as before.

Partial degumming tests were conducted with four different alkalies; namely, sodium hydroxide, sodium carbonate, sodium oleate and sodium silicate (40 degrees Baume, 8.9% Na_2O, 29.0% SiO_2).

In using the strong alkalies, such as NaOH, it was necessary to employ dilute solutions in order to avoid any possible decomposition of the silk fibre itself. With each reagent concentrations of 0.00025, .00050, .0010, .0015, .0020, .0025, .00375, and .005 normal solutions were used, employing 100 grams of solution to each gram of raw silk.

In order to employ higher concentrations, and to attain higher pH values without danger of attacking the silk fibre, a partial degumming was first made with .006 N sodium hydroxide on a 10 gram sample using fifty times the weight of silk. The spent boil-off liquor was removed from the partially degummed silk and combined with the water rinsings from the same silk. The combined liquor was diluted to exactly 1 liter at 20° C. From this solution 100 cc. aliquots were taken and boiled for one hour under the reflux condenser with additional sodium hydroxide, so that the resultant normalities of the total NaOH used amounted to the following concentrations: .004N, .0115N, .0128 and 0.102N.

Where deficient alkali was used to establish equivalence the samples were titrated with 0.005 N sodium hydroxide solution. Where excess alkali was present, the excess was back-titrated with 0.01 N sulphuric acid. All titrations were conducted in 40% alcoholic solutions using phenolphthalein as the indicator. A specimen of measurements and calculations for a single test follows:

Weight of raw silk .....1.099 grams
Moisture content .....5.00 per cent
Initial dry weight of raw silk .....1.047 grams
Dry weight after partial degumming .....0.874 grams
Dry weight after total degumming .....0.853 grams
Sericin removed in partial degumming ....0.173 grams
Total sericin present 0.194
Percentage sericin removed 89.3%
Standard NaOH added initially .....20 cc. .0054N
Enough distilled water was added to dilute to 109.9 cc.
pH of initial bath .....11.2 at 20° C.
pH of bath after partial degumming ..... 8.4 at 20° C.
Standard .005N NaOH used in titration .... 7.4 cc.
Total alkali added in reaction and titration
$.020 \times .0054 + .0074 \times .0054 = 0.000148$ gram equivalents

$$\text{Binding weight} = \frac{0.173}{.000148} = 1170$$

Gram equivalents of NaOH per gram of sericin initially present in boil-off bath $= \dfrac{0.020 \times .0054}{.194} = 0.000555.$

The experimental data of all runs are summarized in Tables I to V inclusive.

TABLE I

Data for 0.0054 N. NaOH Solutions

100 grams solution per gram silk Time: 2 hours

Number	Initial Volume of Alkali—cc.	Initial Dry Weight Silk	Dry Weight After Partial Degumming	Dry Weight After Total Degumming	Sericin Removed in Partial Degumming	Total Sericin Content	Percent Sericin Removed	Initial pH	Final pH	Alcoholic Titration, cc. NaOH 0.0054 N.	Calculated Binding Weight
1	5	1.090	.926	.890	.164	.200	82.0	9.9	7.2	12.6	1730
2	5	.996	.886	.816	.110	.180	61.2	9.9	7.2	10.0	1360
3	10	1.033	.872	.837	.161	.196	82.2	10.5	7.4	10.5	1450
4	10	1.004	.881	.825	.123	.179	68.9	10.5	7.6	9.7	1150
5	15	1.013	.857	.819	.156	.194	80.4	10.7	8.0	8.0	1258
6	15	.993	.838	.811	.155	.182	85.4	10.7	7.6	10.8	1118
7	20	1.041	.861	.832	.180	.209	86.1	11.2	8.35	8.0	1186
8	20	1.047	.874	.853	.173	.194	89.3	11.2	8.4	7.4	1170
9	30	1.061	.863	.857	.198	.204	96.7		8.8	6.0	1018
10	30	.985	.777	.781	.198		100		8.9	7.0	993
11	40	1.038	.838	.839	.200		100		9.2	3.5	854
12	40	.983	.783	.785	.200		100		9.2	4.0	844
13	50	1.098	.857	.864	.241		100		9.4	7.0	782
14	50	.988	.793	.798	.195		100		9.5	4.0	670
15	106	1.066	.825	.832	.241		100		10.1	18.0*	535
16	109	1.091	.877	.866	.214	.225	94.6		10.1	13.0*	450

* Titration with 0.005 N. H_2SO_4.

TABLE II

10.152 grams raw silk degummed with 500 cc. 0.006 N. NaOH, diluted to one liter after rinsing. Dry weight of silk after rinsing = 8.1893 grams. 100 cc. aliquots containing .1963 grams of sericin were taken and boiled for 1 hour with the following additions of alkali:

No.	Vol. of Alkali cc.	Normality of Alkali added	Final pH	Alcoholic Titration cc. acid	Binding Weight Calculated
17	6	.02	10.8	6.5	301
18	6	.02	10.8	6.5	300
19	100	.02	12.1	176.4	276
20	100	.02	12.15	166.4	239
21	25	.50	13.0	118.2	141
22	25	.50	13.0	118.0	140

The acid used for titration was 0.0107 normal.

TABLE III

Data for 0.0052 N. Na_2CO_3 Solutions

100 grams solution per gram silk — Time: 2 hours

Number	Initial Volume of Alkali Added	Initial Dry Weight Silk	Dry Weight After Partial Degumming	Dry Weight after Total Degumming	Sericin Removed in Partial Degumming	Total Sericin Content	Percent Sericin Removed	Initial pH	Final pH	Alcoholic Titration .0054 N. NaOH	Calculated Binding Weight
23	5	.969	.822	.792	.147	.177	83.0	9.7	7.8	9.0	1840
24	5	.910	.788	.755	.122	.155	78.7	9.5	7.4	9.0	1525
25	10	.923	.770	.748	.153	.175	87.5	10.6	8.0	9.6	1395
26	10	1.042	.911	.854	.131	.188	69.6		7.9	6.6	1426
27	10	.824	.708	.670	.116	.154	75.4		8.1	6.8	1250
28	20	.874	.727	.722	.107	.152	96.8	11.1	8.9	9.1	898
29	20	1.024	.872	.842	.152	.182	83.5		8.7	6.4	1062
30	20	1.010	.848	.805	.162	.205	79.0		8.5	6.5	1130
31	30	.939	.762	.756	.177	.183	96.8		9.0	4.0	985
32	30	.934	.770	.755	.164	.179	91.7		9.0	3.5	926
33	40	.899	.711	.713	.188	.186	100		9.3	3.1	828
34	40	1.022	.824	.824	.198	.198	100		9.3	3.6	861
35	50	1.030	.834	.837	.196	.193	100		9.3	7.7	639
36	50	.874	.701	.704	.173	.170	100		9.6	3.5	618
37	75	1.031	.827	.831	.204	.200	100		9.8	0.5	520
38	75	.958	.757	.760	.201	.198	100		10.0	1.4*	536
39	97	.968	.776	.780	.192	.188	100		9.9	2.2*	399
40	97	.966	.776	.779	.190	.187	100		10.3	4.5*	379

* Alcoholic Titration with .0107 N. H_2SO_4.

TABLE IV

Data for 0.0027 N. Sodium Oleate Soap Solutions

100 grams solution per gram silk — Time: 2 hours

Number	Initial Volume of Alkali Added	Initial Dry Weight Silk	Dry Weight after Partial Degumming	Dry Weight after Total Degumming	Sericin Removed in Partial Degumming	Total Sericin Content	Percent Sericin Removed	Final pH	Alcoholic Titrations .006 N. NaOH	Calculated Binding Weight
41	5	.953	.852	.766	.101	.187	54.0	6.9	12.9	1110
42	5	.965	.845	.795	.120	.170	70.5	6.4	13.0	1312
43	10	.916	.826	.762	.090	.154	58.5	7.1	10.2	1020
44	10	.950	.826	.763	.124	.187	66.3	7.1	10.3	1400
45	15	.974	.840	.786	.134	.188	71.2	7.3	11.7	1212
46	20	.879	.752	.727	.127	.152	83.5	7.8	9.5	1145
47	20	1.017	.868	.808	.149	.209	71.2	7.5	9.3	1357
48	30	1.015	.830	.797	.185	.218	84.8	8.2	11.0	1255
49	30	.886	.738	.710	.148	.176	84.1	8.4	7.8	1152
50	40	.930	.754	.735	.176	.195	90.3	8.4	10.0	1050
51	40	.925	.777	.756	.148	.169	87.6	8.55	8.1	945
52	50	.963	.779	.778	.184	.185	99.5	8.9	10.0	952
53	50	.961	.772	.771	.189	.190	99.5	8.6	10.0	979
54	75	1.013	.827	.831	.186		100	8.9	15.0	635
55	75	.944	.770	.775	.174		100	9.0	15.8	584
56	97.4	.974	.770	.774	.204		100	9.1	3.3	722
57	95.1	.951	.771	.774	.180		100	9.2	5.2	625

TABLE V

Data for 0.0062 N. Na_2SiO_3 Solutions

100 grams solution per gram dry silk — Time: 2 hours

Number	Initial Vol. of Alkali—cc.	Initial Dry Weight Silk	Dry Weight After Partial Degumming	Dry Weight After Total Degumming	Sericin Removed in Partial Degumming	Total Sericin Content	Percent Sericin Removed	Initial pH	Final pH	Alcoholic Titration NaOH 0.0012 N—cc.	Calculated Binding Weight
58	5	.921	.807	.796	.114	.125	91.1	9.2	7.6	37.0	1512
59	5	.923	.817	.756	.106	.167	63.5	9.2	7.2	43.0	1282
60	10	.882	.755	.715	.127	.167	76.0	9.4	7.5	56.5	978
61	10	.883	.760	.724	.123	.159	71.4	9.4	7.8	43.0	1093
62	20	.983	.801	.797	.182	.186	98.0	9.6	8.2	42.0	1045
63	20	.964	.795	.774	.169	.190	89.0	9.6	8.2	37.0	997
64	30	.944	.764	.757	.180	.187	96.2	9.7	8.7	37.0	781
65	30	.936	.747	.738	.189	.198	95.5	9.7	8.7	37.0	820
66	40	.871	.718	.722	.153		100	9.8	9.0	24.0	552
67	40	.868	.694	.696	.174		100	9.8	8.9	25.0	625
68	50	.970	.799	.805	.171		100	9.8	8.9	7.0*	480
69	50	.970	.775	.780	.195		100	9.8	9.0	5.3	565
70	75	.909	.738	.745	.171		100	9.8	9.3	8.0†	425
71	75	.905	.728	.735	.177		100	9.8	9.4	9.0†	450
72	89.6	.896	.718	.722	.178		100	9.9	9.5	18.0†	431
73	87.5	.875	.703	.709	.172		100	9.9	9.5	12.0†	384

* Titration with 0.0066 N. NaOH.

† Titration with 0.0079 N. H_2SO_4.

Interpretation of Results

The binding weight of sericin was found to vary over a range of values from 2100, when peptized by distilled water, down to 140, when dissolved by 0.1 N NaOH. In the latter case tests were conducted so as to avoid reaction with the silk fibre.

Relation of Binding Weight to pH

It is customary to relate the properties of a protein to the pH of the existing solution. In this case the binding weight of the sericin at equilibrium should be related to the pH of the spent boil-off bath. The properties of sericin, such as acid and alkali binding, swelling, viscosity, electrical conductivity, have been so related by Kodama;[8] the alkali consumption in degumming has been so related by Takahashi.[21] The same pH relation is employed by R. A. Gortner[3] on the properties of proteins; by A. N. Rogers[18] on oil adsorption by sericin; by H. H. Mosher on silk degumming,[10] and on the peptic digestion of sericin;[11] by W. M. Scott[19] on the control of silk degumming; and by L. J. Henderson[16] on the reaction of proteins by acids and bases.

Following the same precedent in the present investigation it would be proper to relate the binding weight of sericin to the pH of the spent boil-

off bath at equilibrium. Accordingly the binding weight of sericin is plotted against values of equilibrium pH in Fig. 1. It will be seen that in general the binding weight decreases with increasing values of pH with each different reagent, but the relationship is very irregular and is different for each reagent used. The same curve is obtained for both NaOH and

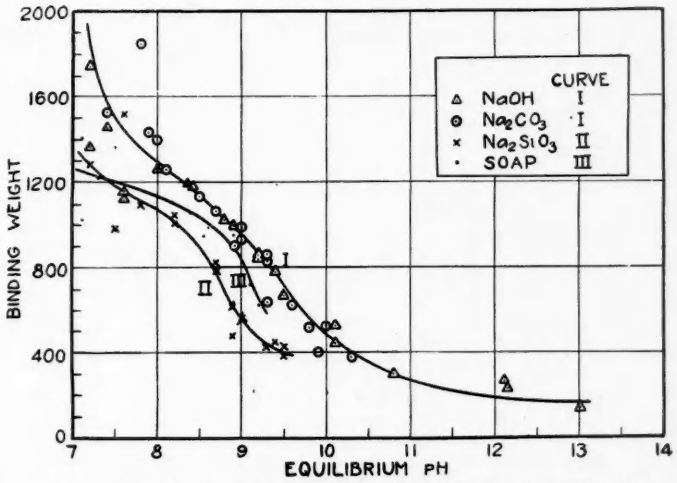

FIGURE 1. BINDING WEIGHT OF SERICIN RELATED TO EQUILIBRIUM pH

Na_2CO_3 because in all cases of partial degumming the carbonic acid was vaporized in the boiling bath making the resultant solutions alike with both alkalies. With soap and sodium silicate different values were obtained, partly because of the buffering action of the released oleic and silicic acids. The curves drawn in Fig. 1 are irregular and the experimental data depart widely, the variation is greater than the experimental accuracy provides. In general it is apparent that the binding weight decreases with increasing pH for each alkali, but the relationship is irregular and cannot be expressed by any simple equation. The gradual reduction in binding weight with increasing pH is an indication of the progressive breakdown of the sericin particle. By relating binding weight with pH the curves of Fig. 1 indicate that the breakdown of sericin is greater with sodium silicate and soap solutions than with caustic soda or sodium carbonate, which is contrary to usual conceptions.

Relation of Binding Weight to Alkali Ratio

A much better correlation of experimental data is obtained by plotting binding weight of sericin against the ratio of the gram equivalents of alkali per gram of total sericin initially present in the bath (Fig. 2). In

this way it will be seen that all binding weights fall on the same curve within the limits of experimental error for all concentrations and all alkalies regardless of pH or alkali used. It therefore seems that the binding weight of sericin is controlled by the ratio of alkali to sericin initially present, rather than upon the nature of the alkali or upon values of pH. The relationship with pH is subject to greater disturbance when highly

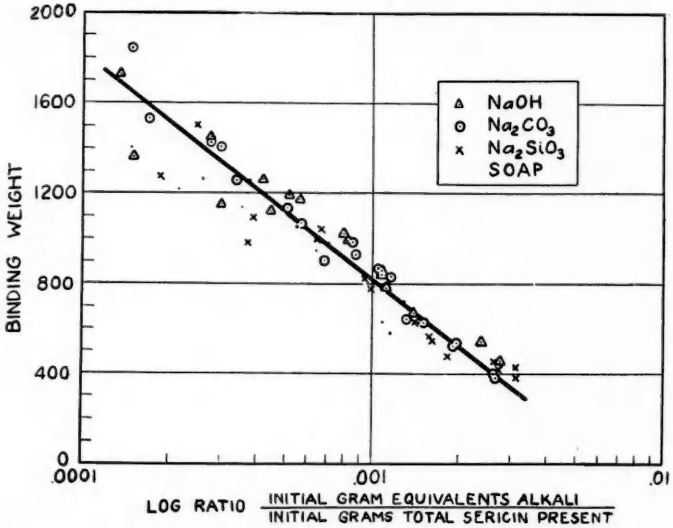

FIGURE 2. BINDING WEIGHT OF SERICIN RELATED TO ALKALI CONCENTRATION RATIO

buffered solutions are used in degumming. One reason for the failure to obtain better correlation with pH values is because values of pH were necessarily measured in cold solutions (20° C.) whereas the equilibrium was established at about 100° C.

In Fig. 2 values of combining weight are plotted against the logarithms of the initial ratio of gram equivalents of alkali per gram of total sericin. This plot is analogous to the plot against pH, since pH represents the negative logarithm of the hydrogen ion concentration.

The equation of the curve drawn in Fig. 2 is

$$B = -1000 \log_{10} R - 2180 \qquad (1)$$

where B = binding weight of sericin

R = initial ratio of gram equivalents of alkali per gram of sericin used in degumming.

This equation holds for experimental values of binding weigth from 140 up to 1730, corresponding to normalities from .0027 up to 0.1 N.

Variations in binding weight of sericin were obtained from 2100, when peptized with distilled water, down to 140, when dissolved in 0.1 N NaOH. This represents a variation of 15 to 1, indicating a progressive breakdown of the sericin particle and indicating that at least 15 amino acids are linked together in a single sericin particle.

Conclusions

1. The binding weight of sericin in a boiling-alkaline bath decreases progressively with an increase in the initial ratio of alkali to sericin present. This relationship can be expressed by the simple equation

$$B = -1000 \log_{10} R - 2180 \qquad (1)$$

where B = binding weight, grams of sericin combined with one gram equivalent of alkali at the point of equivalence

R = initial ratio of gram equivalents of total alkali per gram of total sericin present initially.

This relationship holds for values of binding weight from 2100 down to 140. Experiments were not conducted beyond this range.

2. This relationship holds for all alkaline solutions tested; namely, sodium hydroxide, sodium carbonate, sodium oleate and sodium silicate.

3. The binding weight of sericin decreases with increasing pH for each different alkali, but no simple relationship exists.

It was the original object of this investigation to obtain values of binding weights which could be used in calculating the alkali consumed in degumming silk. The results do not give such information. The alkali-sericin compound corresponding to the point of equivalence used herein still possesses ability to degum silk. The binding weight of sericin as it is first removed by alkali has been found to be approximately 1600, as will be reported in a later paper. The values given by equation (1) really refer to the sericin combined with one gram equivalent of alkali after decomposition has proceeded in the solution to equilibrium, and not as the sericin leaves the silk.

Credit is acknowledged for helpful criticisms by Professors H. L. Fevold and V. W. Meloche.

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Science Discovers Ramie's Faults

SCIENCE has discovered why it is that ramie, or China grass, while one of the glossiest and apparently one of the strongest of the natural textile fibres, has thwarted efforts to utilize it on a large commercial basis. In China and the Far East it has been prepared and spun by hand labor for centuries. Millions of dollars have been spent in attempts to perfect chemical and mechanical methods of decorticating and degumming the fibre, but none have been successful on a commercial scale. The fibre, and yarns and fabrics produced therefrom, have always proved to be weak when subjected to bending and torsion sharply angular to the yarn axis. This was assumed to be a fault of the methods used in preparing the fibre for spinning, but scientific research has proved that it is due to faults in the micellar structure of the fibre, that are strikingly similar to geological faults.

This discovery was made by G. Gordon Osborne, a Textile Foundation fellow working under the direction of Prof. E. R. Schwarz at M. I. T., on Micro-Analysis of Textile Fibres. The second report of his study, appearing in this number, covers "Observations on the Structure of Ramie" and his explanation of the discoveries referred to will be found in the last two sections of the report.

Ramie's brittleness, lack of resistance to flexing, and low-extensibility are due, according to Mr. Osborne's findings, to trans-fibre fissures which vary in depth, and of which several may be found in one cross-section of the fibre. "Mechanical action," he reports, "starts and intensifies the formation of these markings and, as treatment proceeds, the number of trans-fibre fissures increases."

Dichroism of Dyed Fibres as a Means of Studying Micellar Arrangement

By D. R. MOREY *

Introduction and Summary

WHY certain types of dyes are adsorbed by cellulose in a definite oriented manner, and how the orientation or alignment of the micelles or crystalline portions is reflected or imitated by such dye molecules as well as how this dye alignment may manifest itself through the phenomenon of dichroism, or of polarized fluorescence, have been discussed.[1] Although, for reasons which will shortly appear, the quantitative studies made by the author have been based solely on polarized fluorescence,[2] the phenomenon of dichroism may also be used to advantage in fibre structure studies. This article takes up its use as a quantitative tool, and its advantages and disadvantages when compared with the polarized fluorescence method.

Photometry of Dichroism

AN example of dichroism appears in Fig. 1, which shows a well-oriented viscose rayon filament dyed directly with Congo Red. By means of filters, the impinging white light is reduced to a band in the green, where the absorption of light by the dye is greatest. It is seen that, where the electric vector is parallel to the filament, there is strong absorption. The filament has been bent to show how the amount of light absorption depends on the relative positions of electric vector and filament axis. In Fig. 2 the electric vector is at right angles to its direction in Fig. 1. This dependence of light absorption on the direction of polarization gives us a means of determining how well the dye particles are aligned, and thus an insight into how well the cellulose structure (which dictates the dye alignment) is arranged. A great change of intensity upon rotation of a polarizing prism indicates that the particles are well oriented, whereas a uniform intensity for various positions of a prism indicates that they

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are randomly arranged. The problem at hand is to obtain a measure of the dichroism and to interpret it in terms of percentage orientation of the fibre. J. M. Preston has been the first to attack the problem,[2] using a

FIG. 1

FIG. 2

double-image prism device within the eyepiece to measure the intensity change illustrated in Figs. 1 and 2.[4] In this laboratory the same photometer arrangement used for intensity measurements on fluorescence was

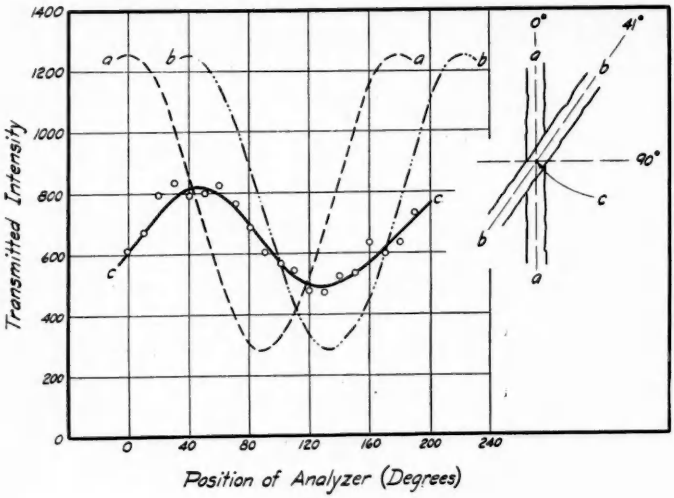

FIG. 3

easily adapted to the problem by removing the fluorescent card (which served as the comparison source of light) and substituting a magnesium carbonate block. The face of this was illuminated by the incandescent

bulb, which also radiated the fibre. Relative intensity readings for various analyzer positions were made as before by matching the intensities of the fibre and the comparison mirror.

If a dyed fibre is dichroic, the energy per unit time and area absorbed from a beam of plane-polarized light is a maximum for one position of the fibre, and a minimum at 90° to this position. There are several ways of combining these maximum and minimum values so as to obtain an expression or measure of orientation. In developing a measure to use with polarized fluorescence, the expression

$$\% \text{ orientation} = \frac{I_x - I_y}{I_x + 2(I_y)} \times 100 \qquad (1)$$

was found to be most satisfactory. I_x and I_y are the maximum and minimum intensities viewed through a polarizing prism. It is desirable to have an expression to use with dichroism which is similarly derived and allows comparison of the two.

In actual practice the measurable quantities are I_o, the intensity of the light incident upon the fibre; I_a, the intensity transmitted through the fibre with the prism set for minimum absorption, and I_b, transmitted intensity at maximum absorption. The losses of intensity are $I_o - I_a$ and $I_o - I_b$, and represent losses due to: (1) absorption by the dye; (2) absorption by the cellulose itself and by natural pigments and impurities in the fibre together with reflection and scattering by the fibre. The second source of loss is undesired, and partially masks the dichroic effect of the dye. It is therefore necessary in dichroic work to mount the fibre in a medium of suitable index of refraction, since otherwise the diminution of I_o due to reflections is so large that the results are of little value. In examining fluorescing fibres, a mounting medium is of much less importance and may be omitted.

Effect of Fibre Properties

The quantity $I_o - I_a$ may be put equal to the sum of the loss due to the dye (D_a), and that due to the fibre (F). Then $I_o - I_a = D_a + F$, and similarly $I_o - I_b = D_b + F$. Now placing D_a and D_b in an expression similar in form to (1) we obtain for a dichroic fibre:

$$\% \text{ orientation} = \frac{I_a - I_b}{3(I_o - F) - 2(I_a) - I_b} \times 100 \qquad (2)$$

Although I_o, I_a, and I_b may be measured easily, the quantity F is difficult to determine; its appearance in the expression for orientation is an obstacle to accurate measurements. One can dodge the difficulty and obtain approximate results by assuming F to be negligible. On this assumption, the average orientation of several flax fibres dyed with Congo Red was found to be 57%—appreciably lower than the value obtained using the fluorescence method (73%).[2] For precise measurements it appears that the effect of the fibre itself on the transmitted light cannot be neglected. The fluorescence method has a distinct advantage here since no quantity corresponding to I_o enters into the measurements; also the effects of absorption and scattering by the fibre diminish I_x and I_y in the same proportion, and thus do not change the percentage orientation calculated from them.

Previous Work

Preston has derived an expression for use with the dichroic method,[3] assuming no diminution of the incident light by the fibre itself. His expression:

$$\% \text{ orientation} = p - 1/p + 2 \times 100$$

where p is the ratio of the optical densities observed with the electric vector parallel and perpendicular to the fibre axis, may be expressed in the form:

$$\frac{\log I_a - \log I_b}{3 \log I_o - 2 \log I_a - \log I_b} \times 100 \qquad (3)$$

using the symbols already defined for (2). This expression differs from (2) in the absence of a term containing F, and in the appearance of logarithms due to the choice of optical density, rather than intensity, as the manner of expressing the data. The orientation of a given fibre when calculated from (3) would not have the same numerical value as that assigned to this fibre by formula (2), with F assumed zero, for the two scales are different. Preston's scale gives larger numbers for a given state of alignment. Expressed on this larger scale, the orientation of ramie as determined by Preston is given as 73%.[3]

Without knowing the values of I_o, I_a and I_b, which gave this figure, one cannot exactly calculate to what the 73% would correspond on the scale of formula (2) since there is more than one set of values of I_o, I_a and I_b which can give 73%. However, it is possible to make an estimate. In observations on flax, dyed to a depth suitable for dichroic measurements, I_a was found to be about 85% of I_o. Using this figure, a calculation of the value of I_b in terms of I_o necessary to give 73%, using formula (3), resulted in $I_b = .23(I_o)$. Inserting these values in (2), and assuming F zero, we obtain 58% as the probable orientation of ramie as measured by Preston, but expressed on a scale allowing comparison with the value 69% obtained for ramie with the fluorescence method.[2] This difference seems too large to be entirely explained by errors; it indicates again that we are not justified in assuming F zero.

However, the approximate orientation values yielded by the dichroic method are not without value, especially when no suitable fluorescent dye can be found. For example, the author has so far been unable to find a dye which fluoresces well when applied on a tannin mordant. There are, however, many dyes used on a tannin mordant which have a well-marked absorption in the visible region of the spectrum, and, therefore, the dichroic method is applicable. Tannin-mordanted samples of ramie dyed with Methyl Violet, Rhodamine B, Rhodamine 6GDN and Victoria Green (DuPont) showed very little or no dichroism, indicating that the mordant-dye complex is precipitated within the fibre at random.

Spiral Measurement

Spiral structures are indicated by displacements of the intensity curves, as is the case with fluorescing fibres. Tests made by examining the contact area of two rayon filaments (Congo Red dyed) crossed at 41°, thus simulating at C a fibre with a 20½° spiral, indicated again that the spiral

characteristics are those of the part nearest the objective. (See Fig. 3.) This appears reasonable when we consider the two portions of the fibre, each with its own structural direction, as two tourmaline plates or nicol prisms in series and inclined at 41° to each other. Unpolarized light passed through such a system emerges with its directional properties determined solely by the second prism.

Although several flax fibres showed an average spiral somewhat smaller than the value previously obtained for flax with the fluorescence method, the difference does not appear due to the mode of measurement.

We may sum up spiral measurement by saying that the methods involving dichroism and fluorescence respectively behave similarly and are equally useful.

References

1. D. R. Morey. *Tex. Rsch., 3,* 7, 325–45 (1933).
2. D. R. Morey. *Tex. Rsch., 4,* 11, 491–512 (1934).*
3. J. M. Preston. *J. Soc. Dyers and Col., 47,* 312 (1931).
4. J. M. Preston. "Modern Textile Microscopy," P. 141. Emmott & Co., London.

* A correction for a mis-statement appearing on P. 499 of Reference 2 is desirable. The diameter of certain fibrils in a sisal fibre appears as "less than .3 mμ." This should read "less than .3 μ."

Abstracts

This section is compiled under the direction of the Committee on Abstracts and Bibliography: Prof. E. R. Schwarz, Chairman, Dr. W. E. Emley, Prof. Louis A. Olney and M. W. Weiss.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Alkaline Copper Solution on Silk Fibroin: Action of. IX. Chemical Reactions and Solution Phenomena in the System of Fibroin-Copper-Alkali. X. Application of the Method of Conductometric Titration to the System Fibroin-Copper-Alkali. Y. Takamatsu and S. Nomura. *J. Soc. Chem. Ind., Japan* 37, Suppl. binding, 1934, P. 149–50; cf. *Chem. Abs.*, 1934, V. 28, Col. 3239, 4912. (W)

Filament Formation: Theory of. (German.) R. Klaus. *Die Kunstseide,* May, 1934, P. 148–52.

Results of scientific research in the fields of crystallization of the micelle structure are applied here and discussed in order to elucidate the method of formation of artificial filaments. The stretching and thinning out of the capillary filaments during the chemical and physical processes involved in their manufacture is discussed, and the factors which influence these results are noted. (S)

Merino Fleece. I. Chemistry of Suint. M. R. Freney. *J. Soc. Chem. Ind.*, 1934, V. 53, P. 131–4T.

Suint samples vary greatly in ash and N content. Suint is normally neutral or slightly alk. but occasional samples are definitely acid. From 10 to 20% of the samples are fatty acid in nature. Lactic acid and hippuric acid were detd. and succinic acid was isolated. Only small amts. of urea and NH_3 were detected. The presence of nitrogenous bases suggests protein decompn. but no pos. protein tests were obtained. N and ash contents of normal suint samples were similar to those of human sweat. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4603.) (W)

Dips and Dipping: Researches into. D. Effects of Dips on Wool. I. Effect of Arsenical Dips on Wool. H. A. Hambrock and T. J. Wilken-Jorden. *Onderstepoort J. Vet. Sci.*, 1934, V. 2, P. 271–98; cf. *Chem. Abs.*, 1934, V. 28, Col. 4165.

The effects of Cooper's powder dip, a proprietary As prepn. used primarily against sheep scab, and Na arsenite dips on the fleece were studied. Dipping resulted in the leaching out of suint constituents, thereby

reducing the hygroscopicity of the raw wool, especially at 100% humidity. The use of arsenicals as dips resulted in the contamination of the fleece with As, some of which (11.5–14.0 mg. As_2O_3/100 g. wool) remained in the fibres even after scouring. When they were used in the correct concns., the dips themselves did not cause any noticeable damage to the fibre, except that Cooper's dip tended to stain the fleece yellow by depositing its insol. constituents. There were indications that the soundness of the fibres may be seriously affected if the dips are more alk. than pH 10.3. Under normal conditions, the undesirable effects of dipping on the fibre soundness were caused by the process of dipping as such and not by the use of the chemicals here studied. Furthermore, these dipping effects in turn were merely secondary causes of damage, the initial and primary cause of fibre damage being the ultra-violet radiations of ordinary sunlight. Arsenates and arsenites seemed to protect the fibre, rather than cause further damage, since pure water was appreciably more deleterious to such radiated wools than was arsenite soln. Cooper's dip rendered addnl. protection to the fibre, the yellow film staining the fibres impeding the penetration of the ultra-violet rays to the fibre itself. The natural grease and suint on the fibres did not afford sufficient protection against the effects of sunlight. The theoretical implications of these observations are discussed and explained. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4239.) (W)

RAYON: STUDIES ON THE MICROSTRUCTURE OF—BY METACHROMASY. K. Ohara and R. Mizuno. *Artificial Silk Staple Fibre J. Japan*, 1933, V. 1, P. 10–12.

Examn. of the cross-section of the fibre of various rayons dyed with Oxamine Blue 4RX indicated that the intensity of colors of inner and outer layers of the fibre are not uniform and the color observed from an extrenal appearance is due to a combination of these colors. This test is good for an identification of a fibre but not for the detn. of its structure or density. The outer layer of the fibres of viscose, nitrocellulose and Bemberg rayon dyed pink-red and the inner layer dyed to reddish purple or greenish purple, while the Lilienfeld (viscose) and acetate rayons dyed uniformly with light reddish purple and light pink, resp. Metachromatic tests indicated that viscose, nitrocellulose and Bemberg rayons have a loose structure inside and are more dense in the outer layer. Uniform dyeing in the fibres of Lilienfeld and acetate rayons may be due to the lack of dense "skin" in outer layer. (Copied complete from *Chem. Abs.*, 1934, V. 28, P. 4225.) (W)

SULFUR IN WOOL: STUDIES ON THE ORIGIN OF THE. I. STUDY OF THE SULLIVAN TECHNIC FOR CYSTINE. S. D. Rossouw and T. J. Wilken-Jorden. *Onderstepoort J. Vet. Sci.*, 1934, V. 2, P. 361–8.

The Sullivan reaction (cf. *Chem. Abs.*, V. 20, P. 2686; V. 23, P. 3941) as a quant. colorimetric method for the detn. of cystine was considerably improved by better regulation of the conditions necessary for optimum max. color development. The improvement was brought about chiefly by increasing the cyanide concn. (2 cc. of 10% NaCN) and regulating the time interval between the adding of the naphthoquinone reagent and the alk. sulfite to 20–30 sec. Amino acids, NH_4 salts and Na borate retarded or inhibited the reaction, whereas the chlorides and sulfates of Na and K exercised an acceleratory and intensifying action. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4240.) (W)

VISCOSE: SYNAERESIS AND OTHER PHYSICAL CHEMICAL PROPERTIES OF. (German.) Dr. Heinrich Lotze. *Die Kunstseide*, April, 1934, P. 110–14.

Synaeresis is stated by the author to be the spontaneous giving up of moisture during ageing by a gel. This property together with other characteristic colloidal and physico-chemical properties are discussed with tables and charts in the course of the article. The possibilities of calculating the size of the colloidal particles are explained. Chemical dissociation in viscose is also discussed. (S)

II. YARNS AND FABRICS

CROSS-CUTTINGS IN ARTIFICIAL FIBRES AS A RESULT OF STRETCHING. (German.) Dr. A. Herzog. *Die Kunstseide*, April, 1934, P. 128–9.

The article concerns the formation of fine transverse cracks in silk and in cuprammonium and in acetate rayon as a result of extensions of reasonably great magnitude. Opaque places near the ends of these cracks can be detected with the naked eye, particularly in the coarser fibres such as artificial horse-hair. Examination with the microscope of fibres mounted in Canada balsam, either by transmitted or dark ground illumination, shows the fine transverse cracks because of their air content. The outer edges of the filaments do not show this phenomena, or at least show it to only small extent. (S)

RAW COTTON AND THE YARN AND SHEETING MANUFACTURED FROM THREE GRADES OF AMERICAN UPLAND COTTON: STUDY OF. R. W. Webb, H. H. Willis, M. B. Hays, R. E. Elmquist and K. M. Downey. *U. S. D. A., Tech. Bull.*, No. 406, 69 pp., 1934.

Cotton representing good middling, middling and strict good ordinary grades, 1 in. in staple length and similar in character was manufactured into sheeting and subjected to various phys. and chem. tests. Bleaching resulted in a reduction of one-third in bursting strength. The Cu no. and methylene blue tests showed that the cellulose of the strict good ordinary cotton was less degraded than that of the others. The oxidation product formed showed a greatly increased affinity for methylene blue. At iron temps. below 245° no changes occurred in the cottons. At higher temps. all showed lower breaking strengths, decreased surface reflectance in the violet part of the spectrum, increased fluidity in cuprammonium soln., higher Cu nos. and low methylene blue absorption. Fifty-six references. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4913.) (W)

RAYON: IDENTIFICATION OF. A. Airoldi. *Textilia*, 1933, V. 9, No. 4, P. 15–19.

A survey. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4911.) (W)

RAYON: SIZING AGENTS FOR. (German.) Dr. Franke. *Die Kunstseide*, March, 1934, P. 90–1.

Sizing materials for use on rayon must not attack the yarn but must make it resistant enough for further manipulation. It is stated that rayon requires special sizing agents which do not cause secondary unfavorable

conditions. The use of water emulsion, free-from-water soluble-soaps, mixtures of fatty oils and water insoluble salts of polyvalent metals with fatty acids is recommended. For other sizing materials colloidal silicic acid is suitable and casein may also be valuable in different ways. The article is short but one of a series appearing in this periodical throughout 1934. (S)

RAYONS: CROSS-SECTIONS OF STRETCHED. A Herzog. *Kunstseide*, 1934, V. 16, P. 128–9.

Fine transversal cracks form in all types of rayon filaments when they are extended strongly. Opaque places near the ends of the cracks are discernible by the naked eye in coarse fibres such as artificial horsehair. When the fibres are mounted in Canada balsam and examd. under the microscope by transmitted light or dark-field illumination, the transversal cracks are clearly seen because of their air content. The outer zone of the filament does not show this phenomenon. Photomicrographs are given. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4240.) (W)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

ABSORPTION OF DYESTUFFS BY CELLULOSE. III. COMPARISON OF THE ABSORPTION OF BENZOPURPURIN 4B WITH THAT OF SKY BLUE FF. J. Hanson and S. M. Neale. *Trans. Faraday Soc.*, 1934, V. 30, P. 386–94; cf. *Chem. Abs.*, 1934, V. 28, Col. 2539, 4237.

For both Benzopurpurin 4B (I) and Sky Blue FF (II) the increase of absorption (by viscose sheet) with time agreed with the theory of diffusion. I was absorbed at equil. about three times as strongly as II, but required about twice as long to reach this equil. Both dyes were absorbed only very slightly in absence of NaCl, I having the greater affinity. The quantity absorbed increased rapidly with added salt and showed no signs of reaching a max. under the conditions studied. The quantity also increased with the final concn. of dye in the dye bath, but a given increase in this equil. dye concn. was less effective in promoting increased absorption than was a proportionate increase in the concn. of salt. The apparent diffusion coeffs. in cellulose increased rapidly to a max. with added salt, subsequently decreasing more slowly. (W)

ABSORPTION OF DYESTUFFS BY CELLULOSE. IV. ABSORPTION OF A NUMBER OF RELATED DYESTUFFS OF THE DISAZOBENZIDINE CLASS WITH REFERENCE TO THEIR MOLECULAR STRUCTURE. L. H. Griffiths and S. M. Neale. *Trans. Faraday Soc.*, 1934, V. 30, P. 395–403.

An accurate technic for the measurement of the absorption of dyes on cellulose was applied to a no. of direct cotton dyestuffs of the disazobenzidine series. In all cases the increase of absorption with the time of dyeing agreed with the diffusion equation within the limits of exptl. error. Substitution in the *o*-position of the benzidine nucleus has no great effect on the substantivity of the product, but in the *m*-position it reduces the absorption very much. Substitution of NH_2 for OH in the naphthalene nucleus increases the substantivity, the effect being more marked with viscose as absorbent than with pure bleached cotton. Of the dyestuffs studied those contg. 4 SO_3H groups were less strongly absorbed than those contg. two such groups. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4237.) (W)

DYE SOLUTIONS AND SOLS: CAPILLARY PHENOMENA EXHIBITED BY. W. Garner. *J. Soc. Dyers & Col.*, 1933, V. 49, P. 346–55.

The height to which a dye and its accompanying soln. rise when a capillary material such as filter paper is immersed in the soln. is discussed in relation to the particle size and colloidal nature of the dye. The rate of rise of H_2O and of solns. of dyes and electrolytes, and the influence of concn., pH, and the addn. of electrolytes to dye solns. have been studied. The percentage rise, *R*, as compared with that of the solvent, serves to classify dyes into four groups: (*a*) *R* approx. 100, includes well-leveling acid dyes, of low mol. wt., which form true solns., (*b*) *R* approx. 70, includes moderately well-leveling acid dyes, neutral wool dyes, and some very sol. direct dyes; (*c*) *R* approx. 40, includes principally the well-leveling direct dyes, which form slightly aggregated dispersions in H_2O (mol. wt. 2–5 times normal), dialyze slowly, and have some tolerance toward precipitants; and (*d*) *R* approx. 10, includes poorly-leveling direct dyes, insol. mordant colors, and certain dispersed acetate silk dyes; the solns. are usually colloidal, non-dialyzable and sensitive to precipitants. The practical significance of the results is discussed. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4909.) (W)

DYESTUFFS AS COLLOIDS. Conmar Robinson. *J. Soc. Dyers & Col.*, 1934, V. 50, P. 161–5.

Investigation shows the great importance of purity in investigations and the extreme difficulty of obtaining even qual. results for the particle size of dyes when this is below the limit for visibility in the ultramicroscope. Study of the two benzopurpurins shows that in 0.5% solns. they both contain anion aggregates differing little in size and consisting of a few anions and 20–5% of the Na. On diln. the tendency of the micelle to break down is much greater with the "meta" than with the "4 B" dye. Bordeaux extra is shown to be a dye nearly in true soln., with aggregates contg. fewer anions and very little Na. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4909.) (W)

DYEING WOOL WITH ACID DYES: ACTION OF SULPHURIC ACID IN. S. R. Trotman and H. Horner. *J. Soc. Dyers & Col.*, March, 1934, P. 65–72.

A paper presented at the Nottingham meeting of the Midlands Section, November 9, 1933. The primary object of the experiments described was to find a practical method for distinguishing different qualities of woolen yarns used in the manufacture of hosiery goods. It has been stated that different qualities of wool have different affinities for dyes and this point was first investigated. It appears from the experiments that the maximum quantity of dye absorbed depends upon the amount of sulfuric acid present in the dye-bath. The acid is absorbed rapidily during the first fifteen minutes after introducing the wool, but very little is taken up afterwards . When a high percentage of dye is present, its rate of absorption is more rapid than that of the acid during the first 30 minutes of dyeing, but does not reach a maximum so quickly as that of the acid. The relative rates of absorption of acid and dye are determined by the percentages of each present and the concentration of the bath with respect to the acid. A number of charts and much tabulated detailed data is available in the paper. (S)

IV. Research Methods and Apparatus

Photomicrographic Outfit. Bausch and Lomb Optical Co. *Instr.*, 1934, V. 7, No. 8, P. 171.

This instrument was developed for use by the amateur and is intended for attachment to any of the less expensive types of stand. The camera takes standard Eastman No. 127 roll film and is provided with a side attachment which can be swung into position over the microscope as the camera is swung aside. When the specimen is in focus on the ground glass screen of this side tube, it may be swung out in the action of swinging the camera into position and the exposure made. A pamphlet accompanies the instrument which indicates the methods of making photomicrographs and the necessary accompanying dark room technique. (S)

Polarized Light: Identification and Rapid Check on Textile Fibres by Use of. A. H. Kunz and Anna C. Price. *Tex. Wld.*, July, 1934, P. 78.

A very brief discussion of the application of refractive index determination in polarized light giving in tabulated form the ranges of refractive indices both parallel to the plane of vibration of the light and perpendicular to this direction. In each case there is a range of several figures in the third place for each determination and the authors do not give the difference between the parallel and perpendicular indices which is known as the specific index. The specific index is somewhat easier to use on the whole than the range as noted. The additional table giving the polarization colors produced in the common textile fibres is of only passing interest since the dimension of the fibre as well as the index influences these results decidedly. (S)

Rayon: On the Rapid Identification of Different Types of. (German.) Dr. Silvano Merolle. *Die Kunstseide*, March, 1934, P. 75–9.

The methods hitherto accepted for the identification of the different types of rayon are compared and critically discussed. A color reaction for the detection of viscose which is due to the formation of thionine is given. It is said that this reaction permits the detection of even the slightest traces of sulphur always found in viscose. (S)

Rayon in a Continuous Strand: Test of. (German.) W. Frenzel and K. Langer. *Die Kunstseide*, April, 1934, P. 124–27.

Describes the application of one of the newer types of testing machine which determines the load variation necessary to produce a constant degree of stretching, and which repeats traverses of the yarn through the machine at increasing stretch intervals, thus determining some measure of elasticity as distinct from elongation. A number of difficult charts together with the completed or fully worked up chart are given together with tabulated data. The discussion is insufficiently complete to give the exact means of operation of the machine but references to other literature which doubtless will give this desired information are given. (S)

Weighted Silk: Analysis of. II. Swelling of Heavily Weighted Silks in Cuprammonium Hydroxide Solution. W. Weltzien and Arthur Schotte. *Monatsh. Seide Kunstseide*, 1933, V. 38, P. 243–7.

The swelling power falls with increased weighting; within limits the degree of weighting can be detd. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4912.) (W)

EVALUATION OF AUXILIARY PRODUCTS USED IN THE TEXTILE INDUSTRY. J. Abramovitch. *Tiba*, 1934, V. 12, P. 163–75, 249–55; cf. *Chem. Abs.*, 1933, V. 27, P. 3615; 1934, V. 28, Col. 4238.

A description of quick and simple methods of phys. testing and chem. analysis of wetting agents and detergents, accurate to about 1–2%, which is sufficient for com. evaluation of such products. A 1% aq. soln. should be perfectly clear, turbidity indicating the presence of free fatty acids (in which case the soln. clears up on addn. of NaOH or NH_4OH) or of an org. solvent, which can be detd. by distg. and noting the vol. and b. p. of the distd. solvent. For lathering power of soap a comparative detn. of the amt. of cold H_2O absorbed by the soap in 1 hr. under specified conditions is suggested. For liquid products, the Stiepel method is recommended for lathering power. For detg. wetting power, the increase in length is detd. of a standard highly twisted wool thread when immersed for a definite time (preferably 15 min. or more) in a 1% soln. of the product in distd. or soft water at 45–50°. The technic of the test is described. . . . The active ingredient of synthetic products is best detd. by boiling in about 4% H_2SO_4, decanting the water, dissolving in petr. ether or alc., evapg. to dryness and weighing. Methods for detg. pure dry soap, free and combined alkali, and for detecting rosin, unsaponifiable matter, naphthenates or naphthenic acids, fish oils and silicates are briefly outlined. (W)

INFRA-RED PHOTOGRAPHY: NOTE ON THE TECHNIQUE OF. G. C. Reinert. *Brit. J. Photo.*, Jan. 19, 1934, P. 27–9.

The article notes that the property of infra-red radiation which allows penetration into many dark colored tissues has been turned to account in photographing by transmitted light such objects as are not penetrable by visible light within the wave length range of about 4000 to 7000 Å units. The photographic emulsion used must be sensitized for the infra-red. But these plates are now available more or less commercially through Agfa, Ilford, and Kodak companies. The article gives some detail as to the proper method of development for the plates and appends a very brief bibliography. (S)

DETERIORATION OF WOOL BY ACIDS: NEW MICROCHEMICAL REACTION FOR DETECTING. P. Krais and O. Viertel. *Textil. Forsch.*, 1933, V. 15, P. 35–9; *Chim. & Ind.*, V. 31, P. 928.

The test can detect deterioration even in its early stages and is applicable irrespective of the previous treatment of the wool. When wool that has been deteriorated by acid is treated with an ammoniacal potash soln. it first swells, and bubbles form and are liberated. The method consists in observing the phenomena under the microscope with a magnification of 250–300 diams. To obtain comparable results, the time required for liberation of the bubbles is noted, the degree of deterioration being inversely proportional to the time. The above reagent is specific for this deterioration; the reaction also occurs with untreated wools, but the time required is much greater. If the deteriorated film has been more or less completely removed before the test, spherical swellings form on the surface, and the gas is given off much later. The test can be applied even after dyeing of the wool. (Copied complete from *Chem. Abs.*, 1934, V. 28, Col. 4240.) (W)